IOWA COLLEGE
CHRISTO DUCE
LIBRARY, 1848

THE

AMERICAN NATURALIST

VOL. XXXV. *August, 1901.* NO. 416.

THE TEXAN KŒNENIA.[1]

AUGUSTA RUCKER.

THIS most interesting microthelyphonid was discovered last May in the neighborhood of Shoal Creek, near Austin, Texas, under stones in company with Campodea, Japyx, and Scolopendrella. A short description of it was given by Dr. W. M. Wheeler in the November *Naturalist*, under the title "A Singular Arachnid (*Kœnenia mirabilis* Grassi) occurring in Texas." The writer believed the Texas species to be identical with the Sicilian one figured and described by Drs. Hansen and Sorensen, and therefore wrote of it under that name. A number of specimens have since been examined *in toto* and in sections, and some interesting results have been obtained. It did not seem probable that the Texan Kœnenia had been imported, yet it seemed less probable, though our climate is much like that of southern Europe, that the two species were identical. Close microscopic examination has shown them to be two distinct species of the family Kœneniidæ.

Kœnenia has since been found in Siam and Paraguay and, like all archaic types, it will doubtless be found to be cosmopolitan

[1] *Contributions from the Zoölogical Laboratory of the University of Texas, No. 21.*

in its distribution. A young Danish zoölogist has recently found in Siam a distinct species of Kœnenia which Dr. Hansen is to describe. Dr. Silvestri, the discoverer of the species from Paraguay (*K. grassii*), has promised me a few of his specimens in return for the Texan species, which I hoped to have for comparison before this paper was finished. I have likewise been unable to collect any *K. parvula*,[1] of which species Dr. Wheeler has found a single specimen, which he has briefly described in his paper (p. 233). When descriptions of these species are published a more correct idea can be framed of the valuable taxonomic characters of the hitherto unknown order.

Kœnenia wheeleri n. sp.

I desire now to name our principal Texan form after its discoverer, Dr. Wheeler, and to give along with its internal structure a short description of the characteristics which set it apart as a new and distinct species.

In the beginning I may say we have been more fortunate than Drs. Hansen and Sorensen in being able to distinguish the two sexes. It hardly seems possible that the males of Grassi's species could be so rare when they are so abundant in our species. In fact, in the material collected in the fall, the males predominated. Very few females were to be had then, and those few were so small and insignificant that it was thought they were the males. The criterion taken for distinguishing the sexes in this material was the opaque glistening body in the second abdominal segment of the female, the receptaculum seminis of Hansen. Unfortunately the seminal vesicles of the male are situated in the same region and have much the same appearance; hence Dr. Wheeler, in his interesting paper, was misled into thinking that the male was of the other sex. It was not until fresh material was collected this spring and sections made that the mistake was discovered. In size and general form the sexes are alike, and it was only after examining sections that one could say for the first time that the animal possessing the more complex reproductive appendages is the male.

[1] I have the pleasure also of giving this species its name.

External Anatomy.

On comparing *K. wheeleri* with the figures and descriptions of Drs. Hansen and Sorensen for *K. mirabilis* the following differences are apparent: (1) the number and position of the hairs of the body; (2) the appendages of the reproductive orifice situated between the second and third segments of the abdomen; (3) the three pairs of prominent orifices on the ventral surface of segments four, five, and six, through which the lung sacs are everted; (4) the lateral sense organs of the cephalothorax; (5) the number of teeth on the two last joints of the chelicerae.

FIG. 1. — Ventral surface of the abdomen of male *K. wheeleri*.

The hairs over the ventral surface of the abdomen of the Texan species are more numerous and are distributed in a manner quite different from those over the abdomen of the old-world form. In the second segment of the female there are three rows of plumulose setæ. The first row of six runs across the ventral surface anterior to the middle line and is continuous with the hairs of the dorsal surface. These form a belt around the second segment. The second row of six arises along the base of the triangular flap of the reproductive orifice. The third row is so irregular that it can scarcely be called a row. Here the hairs follow in a fashion the other two sides of the triangular appendage. Fig. 2 is a camera drawing of this portion of a specimen which has been treated with potassium hydrate. The figure clearly shows the arrangement of hairs over this region of the female. The dotted lines of the figure represent the portion of the organ which can be seen only by focusing through the triangular appendage.

In segment two of the male there are three primary rows of plumulose hairs. The first row, consisting of from four to six small setæ, runs across the ventral surface at about the middle of the segment and continues dorsally to form the circular row

of setæ. This second row of four small setæ extends across the middle of the shield-shaped appendage of the reproductive organs. The third set consists of two secondary groups, the first of which, containing eight hairs, runs across a sort of hem attached to the lower margin of the shield-shaped organ. The second set is made up of large plumulose spines arising from the tips of ten papillæ, four of which spring from the edge and six from under the edge of the hem. Fig. 3 is a careful camera drawing of this region of the male. The first row of setæ not on the reproductive appendage is not figured.

Segment three in both male and female has on the two blades of the reproductive appendages irregularly placed hairs which are of varying lengths. In a line posterior to the middle of the segment are eight other setæ in a row continuing with those of the dorsal surface to form the setigerous belt of segment three.

Most remarkable are the differences between segments four, five, and six of *K. wheeleri* and the corresponding segments of *K. mirabilis*. Concerning the fourth segment of Grassi's species, Drs. Hansen and Sorensen have written, "Provided on the ventral side in front of the middle with a wart-like protuberance which bears six stiff setæ, almost spines (*aculei*), arranged in two transverse rows, the foremost of which is arched and has four spines. Grassi seems to consider these spines sensory organs, an opinion we by no means share." In *K. wheeleri* segment four is provided on its ventral side with three pairs of hair groups. The first pair consists of three long backward-pointing setæ on each side of and near the midventral line. These setæ are situated on delicate chitinous flaps of the integument which arise in front of the middle of the segment. The second pair is made up of four much shorter backward-curving hairs arranged in an arched transverse row near the middle of the segment to the right and left, respectively, of the first pair. These hairs are most evidently for the protection of the delicate lung sacs when they are ejected, and for protection of their orifices when they are drawn in. The third pair consists of two small setæ in the same line and lateral to those of the second group. The former are continuous with the belt of setæ encircling the whole segment.

Of the fifth segment nothing is said concerning *K. mirabilis*, while the figures show it to be like segment seven. This is decidedly not the case in our species. The fifth segment is — as far as the setæ are concerned — a facsimile of the fourth.

Again, concerning the sixth segment of the Sicilian species, the Danish investigators write, "It is furnished on its ventral side with a rather strongly protruding wart, bearing a somewhat arched transverse row of six forward-curving setæ. We do not think these to be sensory organs either." In *K. wheeleri* the ventral surface of the sixth segment is in reality less prominent than that of the two preceding segments, for it is lacking in the first group of large hairs situated on the flaps on each side of the midventral line; the flaps, however, are retained. Fig. 1 is a ventral view of the abdominal exoskeleton of a male Kœnenia, which has been thoroughly cleaned of its cellular contents in KOH. In this specimen all six of the sacs are thrown out, and the protective function of the groups of four hairs is quite evident. All the setæ shown in this figure are plumulose; but under a magnification of about 120 diameters they barely appear to be so, and I did not attempt to represent this condition in the drawing.

It was only after repeated attempts that I succeeded in obtaining clear views of the reproductive appendages. In both sexes, segments two and three are conspicuous for their relatively enormous appendages. In the female the midventral surface of the second segment projects downward and backward into a triangular appendage, which is not emarginate at its apex, as in *K. mirabilis*. This projection almost covers a couple of heavily chitinized downward projections of the third segment. The receptaculum seminis opens between these two appendages, while the reproductive organs open further forward into the vagina formed by the three appendages. Fig. 2 shows what I take to be the receptaculum seminis, while the reproductive orifice only shows in section. The male appendages are very

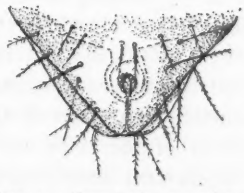


FIG. 2. — Reproductive appendages of female *K. wheeleri*. The round sac in the center of the figure is the receptaculum seminis.

complex and difficult to explain. Fig. 3 will aid in making the account clear. The appendage of the second segment represents in surface view a truncated conical flap having at its base a hem which is notched in the midventral line. The hem near the outer sides of the flap projects into two papillæ, each of which terminates in a heavy spine. Projecting from the under surface of the hem are two pairs of large and one pair of small papillæ, with their corresponding spines. This papillate appendage partially conceals two trowel-shaped, strongly chitinized, downward and backward directed projections of the third segment. The accessory glands and vasa deferentia open near together, in the median line, where the posterior surface of the unpaired appendage is continuous with the anterior surfaces of the paired appendages.

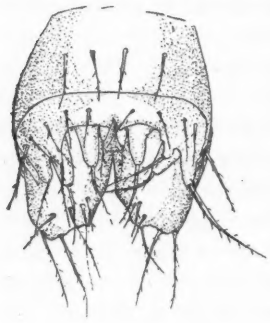


FIG. 3. — Reproductive appendages of male *K. wheeleri*.

Another important specific difference seems to be in respect to the lung sacs, organs which are evidently much more prominent in the Texan species. These organs must, in fact, be entirely lacking in *K. mirabilis*, for such careful observers as Drs. Hansen and Sorensen could not have entirely overlooked them. On examination of a few of our specimens, one cannot fail to observe peculiar little sacs projecting from the ventral surface sometimes of the fourth, sometimes of the fifth, sometimes of the sixth, and occasionally from all three segments. Again a specimen may be found in which all six sacs are invaginated, giving it the appearance of possessing three pairs of stigmatic apertures. Of these organs Dr. Wheeler writes: "In many specimens a delicate sac may be found evaginated from under a flap on all three segments. These sacs are in all probability lung books. They appear to be the only respiratory organs of Kœnenia apart from the delicate integument, which in so small an animal must of itself nearly suffice for respiratory purposes. If I am correct in regarding the above-described

sacs as lung books, they must represent those organs in an extremely simple form, in a form, moreover, which strongly suggests their origin from invaginated appendages serially homologous with those of the cephalic and thoracic segments."

The two anterior sensory organs do not appear different in any respect from the same organs of *K. mirabilis*. The lateral organs, however, though situated in about the same place, consist of three sensory rods each, instead of the two blades. These are short-pointed rods pressed close together and projecting, when at rest, forwards and outward. Fig. 4 is a camera drawing of these lateral sensory hairs, under a high magnification. In cross-section the hairs appear as three rings in contact with one another. I am unable to make out on the surface of these organs anything more than the minute projections which are found over the entire surface of the animal's body.

FIG. 4. — Lateral sense hairs.

The second and third joints of the cheliceræ, which form pinchers, in specimens examined for this special purpose, were found to be each provided with eight teeth. The teeth of the fixed portion are long and very acute, with barbs at the base; while the teeth of the movable joint are short, broad, and blunt.

The above are the most evident differences of the two species of Kœnenia, unless it be that there are more segments in the caudal flagellum of one than of the other. I have examined a number of complete specimens of both males and females, and find in every case that the tail is made up of fifteen segments. Grassi states for his species, which has been redescribed for all other points except this, that it possesses thirteen or fourteen joints.

Internal Anatomy.

In considering the internal anatomy of this minute animal, several difficulties have arisen which I fear I have not entirely surmounted. The extreme minuteness of the cells of the very delicate tissue enclosed in the comparatively heavy chitinous case makes microscopic study rather unsatisfactory.

Integument. — Drs. Hansen and Sorensen state, "As a peculiarity in Kœnenia, we think right to emphasize at once that its skin is but slightly chitinized, especially on the abdomen, where, consequently, there is no distinction between the (dorsal and ventral) plates and the pleura; so the expansion, which the abdomen must be capable of allowing, probably depends on the elasticity of this thin chitin itself." I think had these gentlemen attempted to section Kœnenia they would not have been so emphatic about the thinness of its exoskeleton. The chitinous cuticle, which rests on a delicate hypodermis, corresponds more nearly to that of most spiders, in that over the expanded abdomen it does not appear to form special plates. It also corresponds to spiders, in that it is a flexible or accordion-plaited covering, the folds of which run parallel with the long axis of the body. This arrangement thus allows of great expansion of the abdomen, its function being evidently the same as the folds in the late integument of the abdomen of Thelyphonus. Over the cheliceræ labrum-hypostome and reproductive appendages the chitin is thick and yellow, while between the joints it is very thin. In the floor of the mouth the chitin is thrown into folds, running at right angles to the long axis of the body. This, in sagittal sections of the animal, gives it the appearance of possessing teeth. The entire chitinous surface of the animal is not smooth, but under high magnification appears to be covered with small dot-like elevations.

Kœnenia wheeleri is remarkable for the comparatively thick covering of hairs arising from its flexible cuticle. The smallest hairs are like down, covering the anterior surface of the labrum and the under surface of the hypostome. The longest and most delicate are the tactile hairs of the sixth, seventh, and eighth segments of the third pair of appendages. The broadest and heaviest spines are situated on the underside of the proximal joint of the cheliceræ; otherwise the setæ are distributed as Dr. Wheeler has already shown. All the hairs over the body of Kœnenia, with the exception of the tactile and the very minute ones on the mouth appendages which are too delicate to be made out, are microscopically plumulose.

The muscles of Kœnenia are decidedly striated, like those of insects. They represent a condition of musculature which would be expected in so small and primitive an animal. Worthy of note are the two pairs of simple dorsal and ventral muscles of the abdomen and thorax. Other important muscles are those running from the roof and side of the thorax to the cheliceræ. The muscles of the appendages need not be described, with the exception of those extending from the side of the thorax to be inserted on the thoracic appendages. These muscles arise on the sides of the thorax, opposite to their corresponding legs, and, crossing over just above the subœsophageal ganglion, become inserted on their proximal joints. The only other muscles that need to be mentioned are the primitive dorso-ventral muscles of the thorax and abdomen. These are decidedly a very striking feature in the abdomens of arachnids.

Nervous System. — One of the most singular things about Kœnenia is its large proportion of concentrated nervous substance. The concentration of the ganglia is almost equal to that of the Araneidæ. In this respect Kœnenia is even more specialized than Thelyphonus. There seems to be no reduction of nervous element here due to the absence of eyes, but, like all primitive types, it retains its cephalothoracic ganglia unmodified. The brain and subœsophageal ganglion unite to form one large mass perforated by the small œsophagus. The brain is enormous, occupying the entire dorsal portion of the head above the level of the œsophagus. It innervates the median and lateral sense organs, the labrum, and cheliceræ. The subœsophageal ganglion covers the entire floor of the head and thorax, and shows in section swellings corresponding to each of the five pairs of appendages. With a slight constriction at the waist, the subœsophageal ganglion connects with a single abdominal ganglion which is situated in segments two and three, dorsal to the reproductive orifice. From this ganglion, nerves run to all parts of the abdomen and tail. In its nervous system Kœnenia is thus very unlike the Scorpionidea and differs from Thelyphonus in the relative size of the cephalothoracic ganglion and in the situation of the

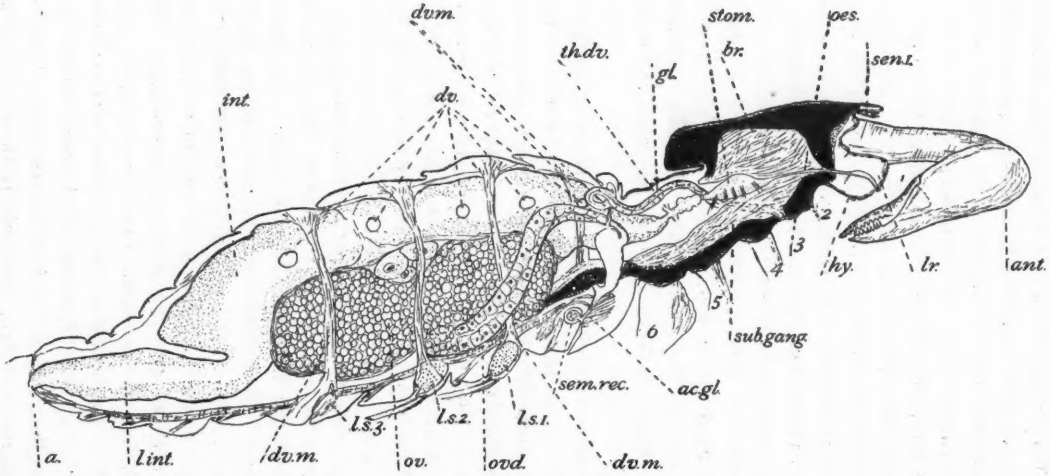


FIG. 5. — Diagrammatic sagittal section of a female *K. wheeleri*. *ant.*, cheliceræ; *ac.gl.*, accessory gland; *a.*, anus; *br.*, brain; *sub.gang.*, sub-œsophageal ganglion; *dv.*, diverticula; *dv.m.*, dorso-ventral muscles; *th.dv.*, thoracic diverticulum; *gl.*, coxal gland; *hy.*, hypostome; *lr.*, labrum; *int.*, intestine; *l.s.1*, *2*, *3*, lung sacs; *oes.*, œsophagus; *ov.*, ovary; *ovd.*, oviduct; *sem.rec.*, seminal receptacle; *sen.1*, anterior sensory hairs; *stom.*, stomach.

abdominal ganglion, which has not been drawn up toward the head in the latter, but remains in the eighth segment.

Digestive System. — The downward-curved, crescentic mouth leads into a strongly chitin-lined pharynx. This in turn runs into a very delicate œsophagus which penetrates the cephalothoracic nerve mass, only to dilate immediately into a pouch-like sucking stomach. This stomach is roofed over by the brain, while underneath it the subœsophageal ganglion extends. At the sides the brain is not continuous with the subœsophageal ganglion, thus leaving a passageway for muscles arising from the sides of the cephalothorax to enter and attach themselves to the stomach. When expanded to its utmost the stomach fits snugly in between the two ganglia, but when pulled on by the muscles it is flattened dorso-ventrally. The comparatively thick-walled stomach opens through a valve-like constriction into the exceedingly thin-walled intestine. The intestine, before it leaves the thorax, gives off a pair of small diverticula. It then passes into the abdomen, becoming much dilated, and giving off five shallow metameric pairs of diverticula, from the third to the seventh segments inclusive. These diverticula are very diagrammatically represented in Figs. 5 and 6, as are all the other organs, save the brain and the anterior portion of the digestive tract as far back as to the first pair of diverticula. At about the eighth segment the thick-walled large intestine begins. Unlike Thelyphonus, no Malpighian tubules are present, opening into the hind gut, before it terminates at the anus. On this point Kœnenia is most primitive, since it seems not yet to have reached the stage in which intestinal diverticula become modified as excretory organs. There are also no salivary glands present ; these would hardly be of any use to an animal living under such simple conditions. The intestine and diverticula are invariably filled with food particles, which have the appearance of yolk granules. Strange to say, — because of the conditions under which Kœnenia is found, — throughout the entire digestive tract no dirt ever appears. This goes to prove that the food is probably derived, as Dr. Wheeler has already suggested, from the eggs of animals with which it associates. The

digestive tract is thus admirably constructed for such an illegitimate practice as egg-sucking.

Excretory System. — I have succeeded in tracing the pair of tubular glands, "tappezzata d' un semplice strato di cellule epiteliali," of which Grassi speaks. According to him, these glands extend through a large part of the cephalothorax, and perhaps have their orifice in front of the third pair of limbs. These excretory organs in reality arise in the second segment of the abdomen, and after forming one or two convolutions run into and straight through the thorax, to terminate between the second and third pair of appendages. There being no Malpighian tubules in the small animal, this simple pair of coxal glands would seem to represent the only excretory organs, unless, indeed, the glandular cells around the respiratory sacs can be considered as possessing excretory functions. If this be the case, the eversible sacs will then have a double function of respiration and excretion like the vertebrate allantois. These cells are not represented in the drawings.

Respiratory Organs. — Respiration in so small an animal as Kœnenia must necessarily be very simple, and, if I have rightly interpreted the facts, we have in this minute Palpigrade the most primitive form of respiratory organs. These organs consist of the three pairs of lung sacs which are situated in segments four, five, and six, with their corresponding orifices on the ventral surface. They are evidently evaginated through the internal blood pressure. For each pair of sacs there is a pair of dorso-ventral muscles, corresponding to the dorso-ventral muscles of Thelyphonus, which have the function in Kœnenia of drawing in the everted sac appendages. These lung sacs possess on their inner surface (inner when they are evaginated) granular bodies which stain a deep blue with alcoholic carmen if they happen to be invaginated, but which take on a normal red stain when the sacs are thrown out. Often, in examining sections through the inverted sacs, one can hardly refrain from calling them tracheæ, so very much do they look like simple tubes. In truth, according to whether the sacs are pulled in by muscles, remaining contracted, or whether they have been pulled in by muscles that have immediately become

relaxed, allowing the sac to flatten dorso-ventrally and wrinkle, do we obtain diminutive tracheæ or simple lung books. After examining a great number of sections one cannot refrain from believing that simple sac tracheæ like those of Kœnenia may have given rise to both lung books and tracheæ in other arachnids. If this be the case, we may hold that Kœnenia, which possesses the simplest phase of these organs, the lung tracheæ (which are in reality abdominal appendages belonging to distinct body segments), is the most primitive of all Arachnoidea.

Circulatory System. — As to the circulatory system, the simplest condition possible exists. A definite heart has not yet made its appearance. The blood can have no regular course through the lacunæ and sinuses, and it probably makes its exchange of gases in the neighborhood of the lung sacs. There must be some definite region for the interchange of oxygen and carbon dioxide, for though Kœnenia is small, its exoskeleton is rather too thick to allow of a general surface respiration. I do not think that the dots over the entire surface of the chitin can be minute pores, which the spiders alone of all the arachnids possess, over the skin of the abdomen.

Reproductive System. — In the female the unpaired ovary begins as a blind tube in the seventh or eighth segment and extends into the third. From each side near the anterior end it is prolonged into two oviducts, consisting, for the greater part of their length, of large glandular cells — the largest cells, in fact, of the body. These ducts run forward and upward, becoming very small and thin-walled ; probably the last portion, for a short distance, being chitin-lined, as in Galeodes. In the second abdominal segment they become very much swollen, forming a sort of pouch on each side, filled with a gelatinous secretion, evidently derived from the gland cells of the oviduct. The duct continuing from each pouch or vesicle runs backward and downward to meet at the place of entrance in the vagina. It is this portion of the reproductive organ, the vitelline vesicles and their terminal ducts, of which Hansen and Sorensen write : " In the second abdominal segment there is an organ which shows the same peculiar luster and refraction of light which one of us knows so well for the

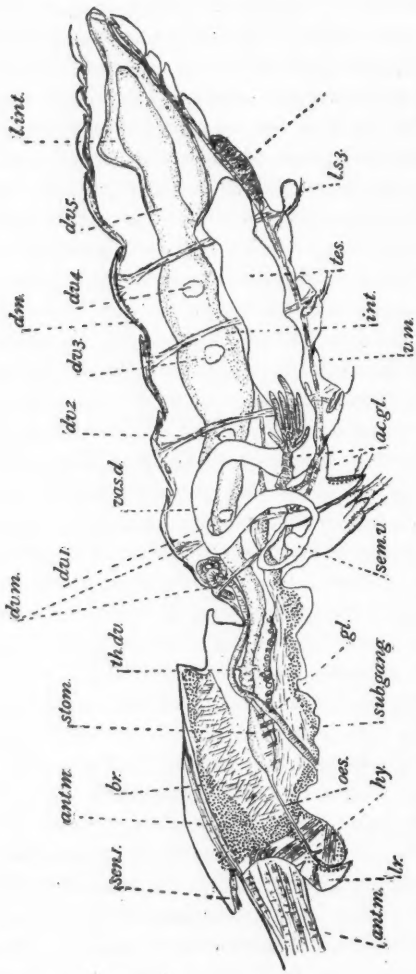


FIG. 6. — Diagrammatic sagittal section of the male of *K. wheeleri*. Lettering the same as in Fig. 5. *ant.m.*, muscles of chelicerae; *tes.*, testis; *vas.d.*, vas deferens; *ac.gl.*, accessory glands; *sem.v.*, seminal vesicle; *dm.*, dorsal muscles; *vm.*, ventral muscles.

receptaculum seminis of small crustacea." In all of my sections I have never been able to see any sign of spermatozoa in the vesicle, which is always full of a non-granular, gelatinous secretion. Just posterior to the outlet of the oviducts, and between the two lateral appendages of this region, is the outlet of the small flask-shaped receptaculum seminis. The accessory glands are small and insignificant, and in the lateral anterior portion of the abdomen they empty into the vagina. The ovary, which fills almost the entire lower portion of the abdomen, does not show its primitive paired condition. Although the muscular walls of the pouch-like ovary are bulged out with what appear to be cells, only a few of these become the eggs, while the remaining seem to be the nurse cells, and are consumed by the growing ova, which early in the spring lie in the upper portion of the organ. Later in the season a few of the eggs fill the entire ovary, while most of the small bodies have disappeared, and in their place a few oil drops remain. These oil drops are seen at this stage in the lumen of the oviducts. Fig. 5 is, for the most part, a diagrammatic sagittal section through a female Kœnenia. The ovary, however, is an exact camera drawing which shows the proportion between the true eggs and the food bodies, and their corresponding position in the ovary of an animal taken early in the spring. In Kœnenia the egg is evidently not fertilized until it reaches the vagina, and all the food that it receives before its fertilization is a product of the ovary and oviduct. The latter must also necessarily furnish the membrane of the egg. Just as there is a pair of dorso-ventral muscles for each pair of lung sacs, there is also a corresponding pair for the reproductive appendages of each segment. These, together with special muscles, undoubtedly cause a slight protrusion and retraction of these organs.

In the male the primitive paired condition of the generative organs is retained. The testes consist of two equally swollen tubes, beginning in the seventh or eighth segment and extending along the floor of the abdomen, to be continued anteriorly into the vas deferens of each side. The vasa deferentia are very much coiled, and fill — at certain times of the year — all

the space in segments two and three of the abdomen, before descending on each side to swell and form the seminal vesicles. From these vesicles the ducts run slightly up and back to a common opening situated between the points of attachment of the two pairs of the dorso-ventral muscles of these appendages. The accessory glands, which are larger in the male than in the female, appear to open into the atrium at a point just posterior to the orifice of the vasa deferentia. The exact courses of the vasa deferentia and the accessory glands are extremely difficult to follow. In places the walls of the ducts entirely disappear, leaving only as a guide, in the case of the vasa deferentia, the contained spermatophores. In some specimens the whole anterior portion of the abdomen is packed with spermatophores. Fig. 6 is a diagrammatic drawing of a longitudinal section through a male Kœnenia, taken to one side of the sagittal plane. Only the testis and vas deferens, with the accompanying accessory glands of one side, are shown. There are, evidently, delicate muscles in the walls of the testes. In the posterior ends of the testes are numerous cells which are undoubtedly sperm mother-cells, while the anterior portion appears to be crowded with small dotted packets. These dots, which must necessarily be the spermatozoa, glisten under transmitted light and rarely show a stain, even with iron-hæmatoxylin. Nowhere throughout the whole course of these organs is there any trace of spermatozoa possessing flagella. It must be that, in Kœnenia, the condition is retained which is found in most crustacea, which possess non-motal spermatozoa often imbedded in gelatinous spermatophores. It is probably due to this spermatophore secretion that the sperm cells almost entirely refuse to take on the stain.

UNIVERSITY OF TEXAS, AUSTIN, TEXAS,
May 23, 1901.

THE MAMMALS COLLECTED IN SAN MIGUEL ISLAND, PANAMA, BY W. W. BROWN, JR.

OUTRAM BANGS.

In the spring of 1900 Mr. W. W. Brown, Jr., made a short collecting trip to San Miguel Island, the largest of the islands in the Bay of Panama, known as the Archipelago de las Perlas. Here he stayed for nearly a month, — middle of April to middle of May, — and in this time secured, he believes, representatives of all the species of land mammals that occur on the island, with the possible exception of some bats.

San Miguel Island is about fifteen miles in length and lies twenty miles distant from the nearest point on the mainland, and sixty miles from Panama. It is composed of low-lying hills clothed in heavy tropical forest, hot, damp, and unhealthy.

The collection of birds made on this trip has already been reported upon.[1] The birds of the island are for the most part like those of the adjacent mainland, and five species only were considered different enough to receive distinctive names. Most of the mammals, on the other hand, seem to be well differentiated island species. I am much indebted to Gerrit S. Miller, Jr., for identifying the bats for me, and to Dr. J. A. Allen for comparing the large opossum with the various forms he has lately described from different parts of northern South America.

One hundred and fifty-seven mammals, belonging to twelve species, were collected by Mr. Brown in San Miguel Island, as follows:

Marmosa fulviventer nob.	4 specimens
Didelphis karkinophaga caucæ Allen . .	2 "

[1] Bangs, Outram. Birds of San Miguel Island, Panama, *Auk*, vol. xviii (January, 1901), No. 1, pp. 24–32.

Bangs, Outram. A New Honey Creeper from San Miguel Island, Panama, *Proc. New Eng. Zoöl. Club*, vol. ii (Feb. 8, 1901), pp. 51, 52.

Lepus incitatus nob.	1 specimen
Dasyprocta callida nob.	6 specimens
Loncheres labilis nob.	19 "
Proechimys burrus nob.	51 "
Zygodontomys seorsus nob.	68 "
Mus musculus Linn.	1 specimen
Mus rattus rattus Linn.	1 "
Mus rattus alexandrinus (Geoff.)	1 "
Vampyrops helleri Peters	1 "
Hemiderma brevicaudum (Wied.)	1 "

Marmosa fulviventer sp. nov.

Four specimens, taken between April 28 and May 8.

Type: No. 8435, adult ♂, Bangs Collection, Museum of Comparative Zoölogy, collected April 28, 1900.

Characters: Nearest to the form of the *Marmosa murina* series from the Santa Marta region of Colombia, — *M. mitis* Bangs. Differing in being smaller; ear smaller; fur shorter, harsher, less silky; color, above more fulvous, less olivaceous, brown; under parts wholly fulvous, darkest on the sides (in *M. mitis* the under parts are yellowish-white); skull similar.

Color: The usual black facial markings, rest of upper parts between cinnamon and tawny-ochraceous; upper surface of arms, sides of neck, and sides, much brighter, more ochraceous-rufous; under parts strong buff, shading into ochraceous-buff on lower sides and on under surfaces of arms and legs, the fur unicolor except on lower sides, where it is pale gray basally; tail dusky, paler below than above; feet and hands dull grayish-white.

MEASUREMENTS.

NUMBER.	SEX.	TOTAL LENGTH.	TAIL VERTEBRÆ.	HIND FOOT.	EAR FROM NOTCH.
8435	♂ adult type	330	175	24	22
8436	♀ " topotype	325	180	23	22
8437	♀ " "	340	175	25	20
8438	♂ old adult topotype	head & body, 170		23	22

Skull, type, adult ♂, basal length, 34.4 ; occipito-nasal length, 37.4; zygomatic width, 20.4; least interorbital width, 6.2; length of nasals, 17.6; width of nasals, 5; length of palate, 18.8; upper tooth row, from front of canine to back of last molar, 15.2; length of single half of mandible, 27.8.

Didelphis karkinophaga caucæ Allen.

Two specimens, ♂ and ♀, were taken May 8. These have been compared by Dr. J. A. Allen with extensive material from South and Central America ; and it is Dr. Allen's opinion that they are best referred to this form, though they do not represent it in its extremes.

Lepus (Tapeti) incitatus[1] sp. nov.

Type (and only specimen): No. 8441, old adult ♀, Bangs Collection, Museum of Comparative Zoölogy. Collected April 30, 1900.

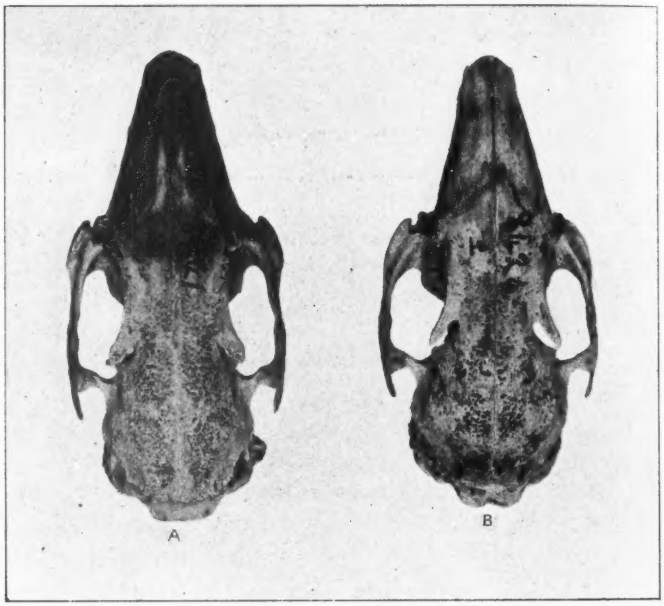
Characters: An island form of *Lepus gabbi* Allen. Distinguished by its larger size, paler, more reddish-brown coloring, and larger, heavier skull, with much heavier, more arched rostrum.

Color: Upper parts tawny-ferruginous ; brightest on top of head, palest — shading to dull ochraceous — on sides ; middle of back and top of head varied by the admixture of black-tipped hairs; nuchal patch, arms, and outer surface of legs clear, bright, tawny-ferruginous ; superciliary stripe dull buffy-white ; outer surface of ear colored like back, with short, dusky tip and narrow, yellowish-white outer border, inside of ear very sparsely haired — the hairs colorless ; under parts soiled white, except underside of neck, which is Isabella-color, shading into dull, tawny-ferruginous on sides of neck.

Skull: Compared with skulls of true *L. gabbi* from Panama and Chiriqui, the skull of *L. incitatus* is larger and heavier throughout ; rostrum much wider and heavier, and more rounded and arched; bony palate wider and longer; molar and incisor teeth heavier.

[1] *Incitatus:* swiftly running; rapid, quick.

Measurements: Type, old adult ♀, total length, 420; tail vertebræ, 20; hind foot (with claw), 80; ear from notch, 45.[1]



A. Type of *Lepus incitatus*, adult ♀.
B. *Lepus gabbi* from Loma del Leon, Panama, adult ♀.

Skull, type, old adult ♀, basal length, 57; occipito-nasal length, 74.6; zygomatic width, 35.4; mastoid width, 23.8; least interorbital width, 16.2; length of nasals, 30.4; width of nasals, 13; length of palatal bridge (from incisive foramina to

[1] Specimens of true *L. gabbi* taken by Mr. Brown at Loma del Leon, Panama, and Divala, Chiriqui, measured as follows:

NUMBER.	SEX.	LOCALITY.	TOTAL LENGTH.	TAIL VERTEBRÆ.	HIND FOOT (CLAW).	EAR FROM NOTCH.
8424	♀	Loma del Leon	340	18	78	38
8425	♀	"	345	20	75	45
10065	♂	Divala	370	20	77	47
10066	♀	"	355	15	75	48
10067	♀	"	370	18	78	50

palatal notch), 9 ; length of incisive foramina, 17 ; width of incisive foramina, 6.4 ; upper tooth row, alveola, 14.6 ; length of single half of mandible, 56 ; lower tooth row, alveola, 15.4.

Remarks. — The hare was not at all common in San Miguel Island, and Mr. Brown saw but one other during his stay. Mr. Brown tells me that *Lepus gabbi* and *L. incitatus* are extraordinarily swift of foot and are seldom seen except for an instant as they dart like a flash through the undergrowth.

The form found in San Miguel Island differs from true *Lepus gabbi* of the Isthmus in its larger size and heavier, slightly different skull. The color is also slightly different, the island race being less marked along the back with black-tipped hairs, and the general coloring is decidedly redder.

Dasyprocta callida[1] sp. nov.

Six specimens, April and May.

Type: No. 8443, adult ♂, Bangs Collection, Museum of Comparative Zoölogy. Collected May 8, 1900.

Characters: A well-marked island species of the *variegata-isthmica* group. Color pale yellowish ; rump hairs black, with white tips. Skull very slender, with long, light rostrum and narrow nasals. Molar-form teeth small.

From *D. isthmica*, the new species can be told by its white-tipped rump hairs (yellow-tipped in isthmica), and from *D. colombiana* (the form of this group inhabiting the Santa Marta region of Colombia), which also has white-tipped rump hairs, by much paler and more yellowish coloration. From either it is easily known by its very different skull (see figure on next page).

From the Central American *D. punctata*, *D. callida* and its allies differ chiefly in the character of the hairs of the rump. In *D. punctata* these are not so elongated and are annulated and colored like the hairs of the rest of the upper parts.

Color: Hairs of upper parts annulated with yellowish and black, giving a slightly variegated look, though the yellowish much predominates, and the general color is yellowish clay-color, brighter, more ochraceous in middle of back anterior to

[1] *Callidus:* that is, taught wisdom by experience; shrewd, cunning.

rump ; rump hairs elongate, black with white tips ; under parts soiled white, the hairs annulated with drab ; feet and hands brownish-black.

The type and No. 8447 are in fresh pelage and are similar. No. 8445, adult ♂, is rather darker and more nearly approaches *D. colombiana* in color. The three other specimens, of which

A B

A. *Dasyprocta isthmica* from Divala, Chiriqui, adult ♀.
B. Type of *Dasyprocta callida*, adult ♂.

two are nursing females, are in worn, shabby pelage, in which the black of the rump has faded to dull brown and the white tips of the hairs are worn down and discolored. In No. 8446, new, normally colored rump hairs are growing in again among the old faded ones.

Skull: The skull of *D. callida* is very distinctive, and can at once be told from that of any of its allies by its slenderness, its long, narrow rostrum and long, narrow nasals. The molar-form teeth are very small.

MEASUREMENTS.

NUMBER.	SEX.	DATE.	TOTAL LENGTH.	TAIL VERTEBRÆ.	HIND FOOT.	EAR FROM NOTCH.
8443, type	♂ adult	May 8	480	25	102	38
8444, topotype	♀ "	April 22	460	22	100	38
8445, "	♂ "	" 21	465	22	102	37
8446, "	♀ "	" 21	510	30	105	38
8442, "	♀ "	" 26	485	20	97	35
8447, "	♂ youngish	" 25	420	20	96	33

NOTE. — All external measurements are the collector's. Hind foot is measured *with* the claw.

Skull, basal length, 85.4 ; occipito-nasal length, 98.6 ; zygomatic width, 44 ; mastoid width, 32 ; least interorbital width, 26.2; length of nasals, 38 ; width of nasals, 15.4 ; length of palate, to palatal notch, 39 ; to end of pterygoid, 55.4 ; upper tooth row (with four molar-form teeth in place), 17.2 ; greatest width of rostrum, 24 ; length of single half of mandible, 58 ; lower tooth row (with four molar-form teeth in place), 18.8.

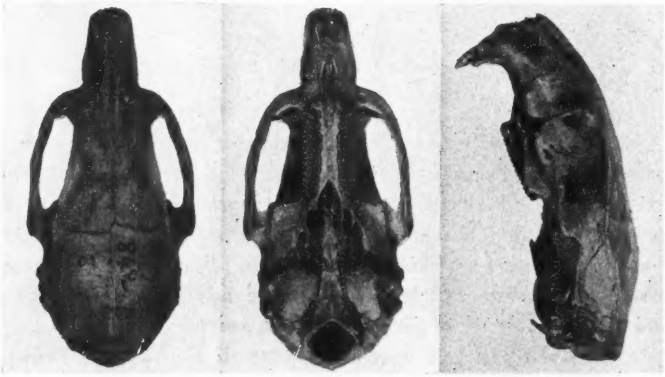
Remarks. — The six specimens were all shot by Mr. Brown among mangroves, the leaves of which they are very fond of. The animal is much hunted by the negro pearl divers, and is exceedingly shy and wary, and for some time Mr. Brown was unable to secure one. One day during a storm he noticed that when a mangrove blew over it was at once stripped of its leaves by the agoutis. Acting upon a plan that this habit of the animal suggested to him, he took several large stones with him, and concealed himself in a tree. After a little he sent a stone crashing through the mangroves and presently saw an agouti cautiously approach the spot, thinking a mangrove had fallen over. The first day he shot two specimens in this way, and afterwards four more.

Loncheres labilis[1] sp. nov.

Nineteen specimens, April and May.

Type: No. 8480, old adult ♂, Bangs Collection, Museum of Comparative Zoölogy. Collected April 26, 1900.

Characters: Most nearly related to *L. caniceps* Günther of Medellin, Colombia. Pelage long and stiff, but *without spines.* Judged by description alone, the new species is brighter and redder in color and its head is not gray. The skull compared with Günther's figures (*P. Z. S.*, 1876, p. 746) is more slender, the palate and post-palatal regions are narrower, and in profile the skull of the island animal is much flatter, the supraorbital ridge not rising in a curve but lying flat and straight.



Type of *Loncheres labilis*, adult ♂ (three views).

Color and Pelage: Pelage moderately long and harsh, but *wholly without spines.* Whiskers very long, black, as also a patch of whisker-like hairs behind the eye and others in front of and on edge of ear. Top of head, nose, and cheeks black, the hairs somewhat annulated with yellowish, giving a pepper-and-salt appearance ; yellowish-white patches at base of whiskers, above eye, and behind ear ; rest of upper parts bright ferruginous, varied by black-tipped hairs along middle of back, varying in amount in different individuals, — some specimens

[1] *Labilis*, gliding, slipping.

being wholly of an intense ferruginous color from nape to tail, others having the rump only ferruginous, the rest of back being darkened by a copious sprinkling of black-tipped hairs; chin dull grayish-white; rest of under parts varying from strong buff to clear ferruginous, some examples having both colors irregularly distributed in patches; upper surfaces of hands and feet yellowish-brown; nails white; tail colored like the body for a short distance, then black, sometimes yellowish-white at tip, thickly clothed with stiff hairs, which, however, do not hide the scales (except at base, where the tail is colored like the body); ears blackish, small and low, nearly naked except for the long black whisker-like hairs that surmount their edges.

Skull: Compared with the figures of that of *L. caniceps*, the skull of *L. labilis* is much more slender, with narrower palatal and post-palatal regions; viewed in profile it is much flatter, with the supraorbital ridge lying flat and straight and not rising in a curve.

MEASUREMENTS.

NUMBER.	SEX.	DATE.	TOTAL LENGTH.	TAIL VERTEBRÆ.	HIND FOOT.	EAR FROM NOTCH.
8480, type	♂ adult	April 26	540	240	47	15
8468, topotype	♂ "	" 26	540	220	48	15
8471, "	♂ "	" 26	540	220	47	15
8470, "	♂ "	" 26	535	260	48	16
8469, "	♂ "	" 26	530	210	48	15
8473, "	♂ "	" 21	500	240	45	15
8474, "	♂ "	" 23	470	220	47	15
8472, "	♂ "	" 26	470	230	45	16
8475, "	♂ young	" 24	440	215	45	14
8477, "	♂ "	May 4	420	175	42	15
8476, "	♂ "	" 5	420	195	42	14

Skull, type, adult ♂, basal length, 47.8; occipito-nasal length, 56.6; zygomatic width, 27.4; mastoid width, 22.4; least inter-orbital width, 12; length of nasals, 16; width of nasals, 7.2; length of palate, to palatal notch, 21.2; to end of pterygoid, 36.4; upper tooth row, 13; length of single half of mandible, 34; lower tooth row, 13.2.[1]

[1] Some skulls that appear to be of about the same age are smaller, others larger.

Remarks. — This island species of Loncheres belongs to a group quite different from either true Loncheres or Isothrix. The skull is, in important characters, similar to that of true Loncheres, but the pelage is very different in wholly lacking spines. Isothrix has still softer pelage and more hairy tail, and also a different skull. I hope some mammalogist, with more material at his command than I now have, will before long readjust and properly divide the different groups of this series of "spiny rats."

Loncheres labilis was abundant in San Miguel Island, but was wholly arboreal, Mr. Brown catching all his specimens in traps set on the branches of large trees. It appears to be diurnal, and on one or two occasions Mr. Brown saw the animal proceeding along the branches with a curious gliding gait, his account suggesting the name I have used for the species. It is the "Raton Marenero" of the islanders.

Proechimys burrus[1] sp. nov.

Fifty-one specimens, April and May.

Type: No. 8458, adult ♂, Bangs Collection, Museum of Comparative Zoölogy. Collected April 30, 1900.

Characters: A large, bright-colored, insular form of the *Proechimys centralis* series. Differing from its nearest mainland ally, *P. centralis panamensis* Thomas, by its larger size and richer red color.

From *P. centralis chiriquinus* Thomas it differs in less spiny back and redder colors. In color it is nearest to *P. centralis centralis* (Thomas), but its feet are much darker.

The skull is slightly different from that of any of the other subspecies. The rostrum is heavier, even, than in *chiriquinus*. The nasals are long, broad, and bluntly truncate posteriorly. (In *centralis* and *panamensis* the nasals are pointed posteriorly, and in *chiriquinus* they are shorter and less bluntly truncate.) Hamular process broad and spatulate, as in the other subspecies. Palatal foramina shorter than in *chiriquinus*, and less parallel-sided and wider open than in *centralis* and *panamensis*.

[1] *Burrus*, red, rufous.

Color and Pelage: Spines confined to anterior two-thirds of back (as in all members of this group of the genus); spines not particularly numerous (as is the case in *chiriquinus*), but well covered by the hair; whole upper parts rich, deep, ferruginous, slightly varied along back by the brownish-black tips of the spines showing through the hair; top of nose, cheeks, and lower sides a little paler, more yellowish; under parts pure white, except anal region and base of tail, which are colored like the back; hands and feet dusky brown, in some specimens slightly grayer along inner edge of metatarsus; tail bicolored, black above, grayish below, well clothed with short, stiff hairs; ears dusky, nearly naked. Young examples, half grown, are much darker, less reddish above; but among the adults there is little variation in color.

Type of *Proechimys burrus*, adult ♂.

MEASUREMENTS.

NUMBER.	SEX.	DATE.	TOTAL LENGTH.	TAIL VERTEBRÆ.	HIND FOOT.	EAR FROM NOTCH.
8458, type	♂ adult	April 30	470	185	58	22
8448, topotype	♂ "	" 21	490	205	60	22
8455, "	♂ "	" 23	470	165	54	22
8449, "	♂ "	" 24	470	165	58	21
8451, "	♂ "	" 22	460	180	58	21
8450, "	♂ "	" 27	440	160	58	22
8459, "	♀ "	" 21	425	150	52	20
8454, "	♂ "	" 21	438	165	52	22
8456, "	♀ "	" 24	410	145	50	20
8460, "	♂ "	May 5	400	140	52	20

Skull, type, adult ♂, basal length, 52; occipito-nasal length, 61.2; zygomatic width, 29; mastoid width, 22.2; least interorbital width, 13.4; length of nasals, 24.2; width of nasals,

7.6; length of palate to palatal notch, 21; to end of pterygoid, 34; length of palatal foramina, 5.2; width of palatal foramina, 3; upper tooth row, 9.8; length of single half of mandible, 33.8; lower tooth row, 10.2.

Remarks. — The San Miguel spiny rat is a slightly differentiated island form of the *centralis* series. It was very common in the island, and Mr. Brown easily took as many specimens as he wanted. It is known to the islanders as "Raton mockungay." They, however, believe the tailless individuals are a different animal. About one-third of the specimens taken were tailless. The animal was generally distributed throughout the island, and was often found living in the huts and sheds of the negroes, like the common rat.

Mr. Brown took *P. panamensis* at Loma del Leon, Panama, and *P. chiriquinus* at Divala, Chiriqui.

Zygodontomys seorsus[1] sp. nov.

Sixty-eight specimens, April and May.

Type: No. 8490, old adult ♂, Bangs Collection, Museum of Comparative Zoölogy. Collected May 5, 1900.

Characters: Similar in color and general appearance to *Z. brevicauda* (Allen and Chapman) of Trinidad, but much larger, hind foot much bigger, tail less distinctly bicolored and more coarsely scaly. Skull larger, rougher, supraorbital heading heavier, transverse ridge where squamosal and supraoccipital meet more pronounced, forward end of zygoma and zygomatic plate standing farther out from skull.

From *Z. brunneus* Thomas, *Z. seorsus* differs by its larger size, larger foot, and richer, more reddish coloration.

Color and Pelage: Upper parts russet-brown, shaded with dull ferruginous, the latter color more intense on the rump; whole dorsal region thickly set with brownish-black-tipped hairs; sides paler, more yellowish; under parts dull buffy-gray, strongly shaded with dull ferruginous in anal region; line of demarcation between colors of upper and under parts indistinct; upper surfaces of hands and feet yellowish-brown;

[1] *Seorsus*, isolated, living apart.

soles naked; ears sparsely haired, dusky; tail very sparsely haired, coarsely scaly, indistinctly bicolored, blackish, rather paler towards base below.

Young examples are rather darker, less reddish, brown above, and the upper surfaces of feet and hands darker brown, less yellowish.

The adults vary but little in color; some specimens are yellower above and others more strongly ferruginous.

MEASUREMENTS.

NUMBER.	SEX.	DATE.	TOTAL LENGTH.	TAIL VERTEBRÆ.	HIND FOOT.	EAR FROM NOTCH.
8490, type	♂ adult	May 5	320	140	34	18
8485, topotype	♂ "	" 4	315	140	34	17
8492, "	♀ "	April 23	310	130	32	17
8495, "	♂ "	" 25	305	125	33	17
8487, "	♂ "	May 2	300	120	30	17
8486, "	♂ "	April 25	295	125	32	17
8496, "	♂ "	May 6	295	120	32	17
8497, "	♀ "	" 8	290	125	31	16
8483, "	♀ "	April 30	290	125	30	18
8484, "	♂ "	" 21	290	118	30	18
8489, "	♂ "	May 5	285	120	30	15
8488, "	♂ "	" 3	285	120	30	16
8481, "	♀ "	April 26	285	110	30	16
8491, "	♂ "	" 25	280	120	30	17
8493, "	♂ "	" 22	275	110	30	17

Skull, type, old adult ♂, basal length, 32.8; occipito-nasal length, 35.2; zygomatic width, 18.4; mastoid width, 12.8; length of nasals, 15; width of nasals, 4.4; least interorbital width, 5.4; width across zygomatic plates, 11.2; length of incisive foramina, 7.4; width of incisive foramina, 3.2; length of palate, to palatal notch, 16; to end of pterygoid, 22; upper tooth row, 5 2; length of single half of mandible, 21; lower tooth row, 5.2.

Remarks. — The San Miguel vesper rat is a strongly marked island species, most nearly related to *Z. brevicauda*, of Trinidad, which it precisely resembles in color and character of pelage. Its much greater size, bigger foot, and different tail distinguish

it, externally, from the Trinidad species, and the skulls of the two can easily be distinguished.

Z. seorsus was an abundant animal in San Miguel Island, inhabiting the dense, swampy woods, and Mr. Brown found no difficulty in trapping it in numbers.

That the vesper rat of San Miguel Island should be so like the Trinidad species is interesting, especially so as the yellow honey creeper of the island (*Cœreba cerinoclunis* Bangs) is much more nearly related to *C. luteola* of Venezuela, Trinidad, and northeastern Colombia than to *C. mexicana* of the neighboring coasts of Panama and Colombia.

Mus musculus Linn.

One adult ♂, taken April 20, 1900.

Mus rattus rattus Linn.

One adult ♂, taken April 20, 1900.

Mus rattus alexandrinus (Geoff.).

One adult ♂, taken April 23, 1900.

The three introduced species of Mus could not have been very numerous in San Miguel, as one individual of each was all that fell into Mr. Brown's traps in over three weeks of collecting.

Vampyrops helleri Peters.

One adult ♀, taken April 25, 1900.

Mr. Gerrit S. Miller, Jr., tells me that this is the only example of this rare bat that he has seen, but the specimen agrees so perfectly with the description that he has little doubt of its being true *V. helleri.*

Hemiderma brevicaudum (Wied.).

One adult ♂, taken April 25.

SOME PROTOZOA OF ESPECIAL INTEREST FROM VAN CORTLANDT PARK, NEW YORK.

GARY N. CALKINS.

BIOLOGISTS in the vicinity of New York are particularly fortunate in having in Van Cortlandt Park a pond which yields a great variety of interesting forms belonging to the lowest classes of animal life. For the casual passer-by the pond is an unsightly spot, but the green scum which covers parts of its surface, and the healthy water-plants around its edges indicate to the microscopist a rich fauna.

Van Cortlandt Park is about nine miles from the Grand Central Station at Forty-second Street, New York, and is reached by way of the Putnam Division of the New York Central Railroad. The trains on this division leave New York at the terminal of the Elevated Railroad at Eighth Avenue and One Hundred and Fifty-fifth Street at least twice each hour, and from this point Van Cortlandt is only four miles. The pond lies in front of the station at Van Cortlandt, extending away to the northeast. Following the railroad up to the northern end of the pond, beyond the spot where an offshoot of the pond passes below the track to the left, a thick bed of lily pads on the right indicates the spot where *Amœba proteus* can be invariably found. A quantity of the superficial slime covering the bottom should be scooped up in a Mason jar, or other collecting jar which has been used only for living things, and with a small amount of water carried back to the laboratory. Immediate examination shows isolated forms of different genera of Protozoa, which will be seen again later in considerable numbers. Among these will be an occasional Amœba, Actinosphærium, Stentor, etc., — forms commonly found in similar pond water. If the material be emptied into flat dishes about 2″ deep and 12″ to 15″ in diameter, and covered with about an inch and a half of tap water, the majority of the forms originally

observed will disappear within a few days, the tap water apparently not agreeing with them. Examination of the material from time to time during the ensuing month, however, shows the gradual return of the original organisms, and with this return the animals are much more numerous than before, and with the advantage that only one type of organism appears to occupy the stage at a time. *Amœba proteus* comes along from four to six weeks after collection, and so constant is this appearance that I can plan in September for my classes in November.

The addition of new tap water has a retarding effect upon the cultures, and a too rapid culture can be checked by this means. A slow culture, on the other hand, should be kept from evaporating and should not be replenished.

In the present contribution I wish to offer a few notes in regard to some forms of particular interest that have appeared during the year, — forms which, for the most part, are rarely observed and but little known. Among these are Nuclearia, Mastigamœba, Multicilia, Lacrymaria, and a species of Actinobolus. It may be of interest, however, to enumerate some of the other forms that are found every year in this water. Of the Rhizopoda there are four species of Amœba (not counting *A. radiosa*, the young form of *A. proteus*); two species of Pelomyxa, three of Difflugia, one of Centropyxis, Arcella, and Euglypha; and of the Heliozoa, Actinophrys, Actinosphærium, Acanthocystis, Pinacocystis, and the dainty stalked Clathrulina are frequently found. Of the Mastigophora there are several species of Euglena, Phacus, Astasia, Trachelomonas, Peranema, Chilomonas, Cryptomonas, Petalomonas; the beautiful colony form Poteriodendron, and the more common colonies Volvox, Pandorina, Eudorina, Gonium, and Synura. The minute choanoflagellates Monosiga and Codosiga, and the dinoflagellates Peridinium and Glenodinium, with their actively vibrating transverse flagella, occur in greater or less abundance. The more common forms of Ciliata in the pond are: Paramœcium, Dileptus, Bursaria, Stentor, Spirostomum, Enchelys, Chilodon, Prorodon, Coleps, Urocentrum, Loxophyllum, Loxodes, Colpoda, Cœnomorpha, Gastrostyla, Urostyla, Euplotes, Kerona, Trichodina

(the last two parasites on *Hydra fusca*), Vorticella, Zoöthamnium, Epistylis. Finally, the Suctoria are represented by the two genera Sphærophrya and Podophrya.

Turning now to the less frequently observed forms, there is, in some cases, apart from the fact that they may be found at Van Cortlandt, little to be said in addition to the existing well-known descriptions. A few remarks as to their mode of life and relationships, however, may not be out of place.

Nuclearia delicatula Cienk.

This form, which was first described by Cienkowsky, has occupied rather a varied position in classification. Placed by some writers with the Heliozoa, by others with the Rhizopoda, it belongs to those forms which, in any artificial classification, must be considered as individuals rather than in groups. The peculiarity of Nuclearia lies in the fact that its pseudopodia, while long and needle-like, and in this respect similar to those of the Heliozoa and the Radiolaria, are at the same time very changeable, like those of the Rhizopoda. When the needle-form pseudopodia are drawn in, the organism moves along like an Amœba and changes its place much more rapidly than the majority of the Heliozoa. When not moving, the animal thrusts out its fine ray-like pseudopodia to a distance equal to one and a half times its body diameter. The animal is restless, however, and retains this condition only a short time, moving off soon with an elongate form and by means of its amœboid processes. Unlike the fine ray-like pseudopodia of the common Heliozoa, the appendages of this form have no axial filaments to give them rigidity, and they frequently branch and sub-branch, while the animal is moving (Fig. 1, *B*). In this condition it surrounds and ingests food particles of various kinds, especially plant cells, euglenoids, etc. I had a very good culture of Nuclearia last year, and had studied the little organism rather carefully for several days, devoting many hours to their mode of life, etc., but I had not seen one divide. One day I had a very fine specimen under an immersion lens, when a colleague, who was born under a lucky star, came in. He had not watched the specimen five minutes before he

remarked, "This specimen is beginning to divide." He was generous enough, however, to give me several views of the animal during the process, which lasted only less than a minute

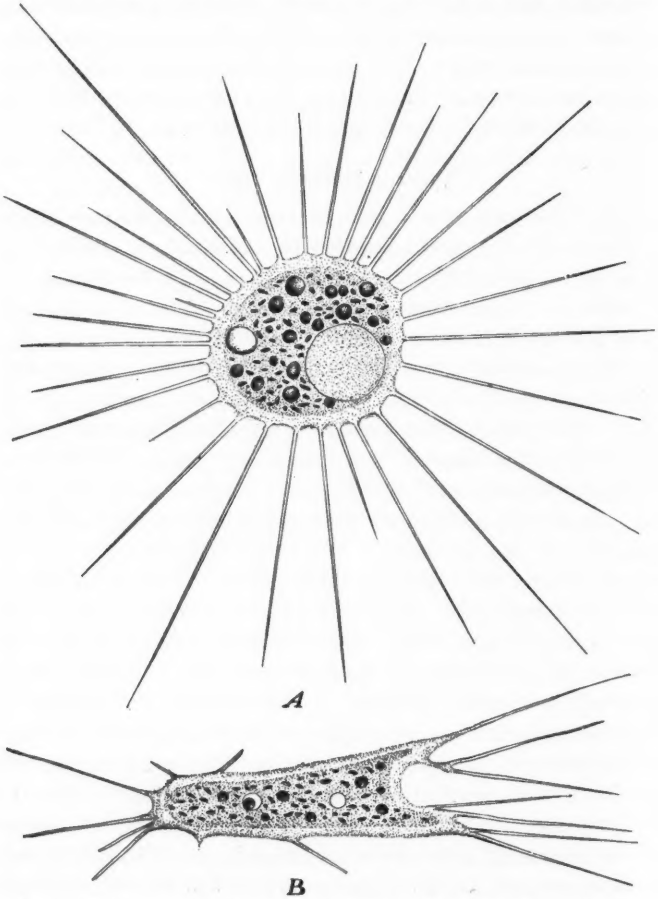


FIG. 1. — *Nuclearia delicatula* Cienk. *A*, the heliozoan condition with ray-like pseudopodia; *B*, the motile amœboid condition. × 1200.

and was not unlike the cleavage of a sea-urchin egg. After division the daughter-individuals moved apart with the characteristic amœboid motion.

It is not an easy matter to interpret Nuclearia, for it may be regarded as a degenerate heliozoan which has lost its axial filaments, or as a primitive form which has never had these peculiar axial structures. The interpretation involves the old dispute over the most primitive forms of Protozoa. Are we, with Klebs, to hold that the flagellates were the most primitive forms ; or with Lankester, that the rhizopods are to be so considered ; or with Bütschli, that the flagellated amœboid forms were the ancestors of both rhizopods and flagellates? The problem, to my mind, has no great importance, for it is quite probable that the Protozoa have not come down without change from that unknown period of the primitive animal forms, while even in historic times they may have been adapted and readapted many times over to changing conditions of environment. The fact that the majority of Rhizopoda have flagellated swarm-spores is not sufficient proof that their ancestors were flagellated, while on the other hand the frequent amœboid condition of the flagellates is equally valid evidence that the rhizopod form was the older. Flagella and pseudopodia are not far removed from one another, and frequent observations have confirmed Dujardin's early view that flagella may become pseudopodia and pseudopodia flagella. The transitional forms such as Dimorpha, Actinomonas, etc., only strengthen the connection, and it will be shown, I believe, that many of the pseudopodia of Heliozoa are similar to the flagella of the Mastigophora. Blochmann has shown, for example, that in Dimorpha the pseudopodia have axial filaments, which, as in Actinophrys, focus in the nucleus or its vicinity. The flagellum, too, is focused at the same point, so that in Blochmann's figure the axial filaments and the flagellum appear to be the same in structure. Artodiscus, according to Pénard, is a heliozoön which dances about the field upon the tips of its ray-like pseudopodia. In this case the pseudopodia are like so many flagella, for there can be no doubt that the motion is due to the contraction and elasticity of the pseudopodia and probably of the axial filaments in them. Acanthocystis, also, has a slow, rolling motion, by means of which it covers a distance equal to twelve times its own diameter in one minute (Pénard). Here, also, although

less than in Artodiscus, the pseudopodia are probably contractile.

There thus appears to be some morphological ground in favor of the hypothesis that Rhizopoda may have originated from the Mastigophora and through the Heliozoa. Artodiscus and Acanthocystis may be regarded as having many flagella of modified form, while Dimorpha, which has a typical flagellate stage, has one true flagellum and at the same time pseudopodia of the heliozoan type. In Actinophrys, Sphærastrum, Heterophrys, etc., the contractile element, whatever it is, is lost, and the pseudopodia appear rigid and apparently serve no purpose in movement. They are of the same type, however, as in Artodiscus and Dimorpha, and, as in the latter, they center at a common point to form a system of rays very much like a centrosphere in Metazoa. In Actinosphærium the rays no longer focus in a common center, although each ends in the vicinity of some nucleus.

In respect of the axial filaments the Foraminifera apparently represent an intermediate stage between the Heliozoa and the fresh-water Rhizopoda. It has been frequently pointed out that the central portion of the pseudopodia of these forms is dense and stiff as compared with the outer plasm, which has the typical flowing motion of a rhizopod, thus reversing the conditions of one of the lobose forms.

If the relations as outlined above would hold good between the Heliozoa and the Mastigophora, then Nuclearia, having lost its axial filaments, finds its real position as an intermediate form between Heliozoa and fresh-water rhizopods, retaining, however, the fine and needle-like pseudopodia of the Heliozoa. Considered in this connection it would be a degenerate form. The entire argument, however, might work equally well the other way, and it might be held that an Amœba such as *A. radiosa*, or *A. tentaculata*, or Nuclearia, develops vibratile pseudopodia having an axial filament of especial contractile substance. The foraminiferan pseudopodia would be a first step in such a development, Acanthocystis, Artodiscus, and Dimorpha successive following steps, until a flagellate would be the outcome. It would be difficult only to place Actinophrys, Actinosphærium,

Heterophrys, Sphærastrum, etc., according to such an hypothesis. In either hypothesis Nuclearia would form an important intermediate link.

Mastigamœba verrucosa S. K.

A number of specimens of this interesting form appeared in one of my cultures during October, and I had a good opportunity to study it. The species is different from that described by F. E. Schultze (*Mastigamœba aspera*), and belongs apparently to that which Kent described as *M. verrucosa*, although in size and general form, etc., it agrees with the description of *Mastigamœba invertens* of Klebs. I could not make out, however, that the organism reverses its axes when it comes to rest, — a point upon which Klebs placed considerable importance.

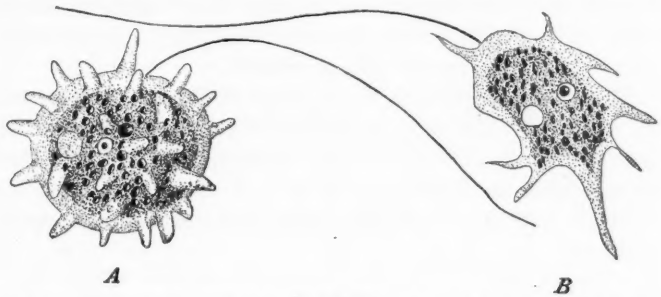


FIG. 2. — *Mastigamœba verrucosa* S. K. *A*, spherical form assumed when swimming with the flagellum in advance; *B*, flattened form with lobose pseudopodia. × 1250.

When first observed this species of Mastigamœba appears like a monad with an irregular outline, which makes its way through the water with a peculiar irregular course, vibrating the while as though shaken vigorously. The cause of the vibration is the action of the rather long flagellum, which is directed in advance. On all sides of the minute body are lobose processes of variable length (Fig. 2). After progressing in this way for some time it finally comes to rest and the pseudopodia are stretched out in all directions, like those of a small Amœba. The flagellum, in the mean time, vibrates slowly at one end. In its usual motile condition the organism is round, but when quiet and with outstretched

pseudopodia it assumes a flattened shape, and a distinct ectoplasm and endoplasm can be made out. After a shorter or longer period of rest the action of the flagellum becomes more and more rapid, the body becomes detached from the substratum and assumes a spherical form, after which it again moves through the water with the peculiar vibrating motion which first attracted my attention. A minute contractile vacuole pulsates at irregular intervals and cannot be made out easily when the organism is moving. A small spherical nucleus lies near the base of the flagellum, but no structure could be made out.

In the resting condition the pseudopodia surround and take into the body small objects of different kinds, which are stored up in the endoplasm until digested. The process is apparently no different from that in *Amœba proteus*.

Mastigamœba belongs to a group of flagellated amœboid forms, the Rhizomastigidæ which Bütschli regarded as ancestral to both flagellates and rhizopods. Klebs, on the other hand, placed the beginnings of both groups farther back, and considered the Rhizomastigidæ as flagellates which have become amœboid.

Multicilia

Only one individual of this interesting genus was seen, and no details were made out save the presence of about twenty long flagella-like cilia distributed evenly about the body. By means of these appendages the organism moved along with a rolling motion.

The search for the beginnings of the ciliate stem from some more generalized organisms has been singularly vain. The conservative structure which the infusorian body presents gives but little clue to their ancestry. In only one other known case (Polykrikos among the Dinoflagellidia) is there a similar nuclear dimorphism, while the almost universal reproduction by transverse division is met with among the Mastigophora but rarely. It is generally conceded that the infusorian stem must have arisen from the flagellate stem at an early period, and must have become progressively differentiated until the present

striking peculiarities were well established. It is assumed by Bütschli and by the majority of others who adopt the hypothesis that the ciliates were derived from the Mastigophora, that the original forms may have been similar to the present genus Multicilia, whose motile organs are more like flagella than they are like cilia. There is no close connection between the cilia and flagella, as there is between the latter and pseudopodia, but Bütschli holds that the Ciliata might have been derived from such a form as Multicilia, in which the motile organs became progressively shortened and increased in number.

There is another hypothesis which has been maintained by Entz and Maupas amongst others, in which the Ciliata are derived from the Rhizopoda through such forms as Actinobolus and the Enchelinidæ in general, two types of which have been found in Van Cortlandt water, Lacrymaria and Actinobolus. Before speaking of this hypothesis in detail I will add a few notes on these two genera.

Lacrymaria olar Ehr.

Of all known micro-organisms, *Lacrymaria olar* is the most remarkable for its elasticity, and manner in which it stretches out a neck-like portion bearing the mouth. The wonderful variability of this portion of the body cannot be represented in a figure, but when one has witnessed the contortions which it undergoes he will never forget the organism. Sometimes the "neck" is stretched forwards in a straight line to a distance equal to six times the diameter of the body; again it may be wound around the body of the animal from the insertion point to the posterior end of the animal, and forward again on the other side; and even then it may stretch out to a considerable distance in advance of the forward end; or, on the other hand, it may be retracted until the mouth appears to be merely the extremity of an ovoid body.

Lacrymaria is not an uncommon form, and in the present connection it is mentioned chiefly for its bearing upon the hypothesis as to the origin of the Suctoria.

Actinobolus radians St.

This infusorian is much more rare than Lacrymaria, and from its rarity perhaps more interesting. It was first described by Stein, then by Entz, who studied it very carefully, and later by Von Erlanger, who made out a number of minor points of structure. It is almost always found in the company of certain forms of Suctoria, Von Erlanger alone not finding these associates. In the Van Cortlandt water the organism was overlooked for some time, because of its supposed identity with the suctorian Sphærophrya, which was present in considerable numbers. Actinobolus is a small spherical organism not much larger than a Urocentrum, and when at rest resembles a Sphærophrya, which in turn resembles an Actinophrys. It is only when this form is studied with a medium high power that a fringe of vibrating cilia can be made out around the profile of the periphery. It may then be seen that there are groups of long cilia (ten or twelve to a group) arranged about the base of each of the long tentacle-like processes, which give to the organism, when at rest, the aspect of a heliozoön (Fig. 3). The tentacles are the most interesting feature of the ciliate, and their function has been in considerable doubt. Stein was unable to assign any function, but described them as retractile, like the tentacles of the Suctoria, to which he compared them, observing at the same time that they might be entirely withdrawn into the body, leaving no trace of their former presence. Entz thought that they might assist the organism in getting

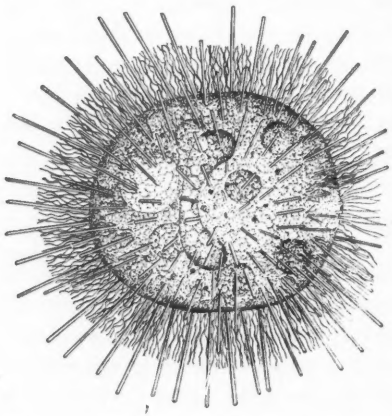


FIG. 3. — *Actinobolus radians* St. The tentacles are partially drawn in and the animal is represented from the side with the small mouth in advance. The nucleus is elongate and constricted. Six Halteria are faintly represented in the endoplasm. × 1200.

food, and observed that the ends of the tentacles were attached to threads of algæ which appeared to be ruptured at the points touched, and he concluded that a secretion of some sort is poured out upon the alga by the tentacle. He also maintained that the organism is exclusively a plant-eater. Von Erlanger described the tentacles as possessing a stiff dart or needle-like trichocyst at the end ; these, he said, are drawn in with the tentacle until, when the tentacles are entirely withdrawn, they form a peripheral layer of trichocysts as in a Prorodon. He also observed that the organism may swallow other living forms and described the seizure of a small flagellate by the cilia about the mouth opening.

There are a few points which I may be able to make in addition to the above. The organism, when feeding, lies attached to the bottom of the vessel by its oral tentacles (*i.e.*, those about the mouth, which are no different from the others on the animal), and mouth downwards. This brings the posterior end of the organism upward, and the anal spot and contractile vacuole can be easily seen and studied while the animal is in this position. The vacuole is not in the center of the dorsal surface, but lies a little to one side (Fig. 4). The tentacles are almost as distensible as the neck of Lacrymaria, and may stretch out a distance of two and a half diameters of the organism, or retract until they disappear in the body. They arise from the substance of the cortical plasm, which is covered by a very thin cuticle or outer membrane, but they cannot be traced into the inner plasm. The cilia are more like flagella than cilia, and move with a vibratory rather than a stroking motion ; while resting they are easy to follow, but when the tentacles are all withdrawn the motion becomes much more rapid, and only the general waving surface can be made out.

It is when the animal is quiet that it takes in food. It remains for hours, sometimes, without giving a sign of feeding, but the tentacles are stretched out to their greatest length and it appears to be merely waiting for something to come. Things do come, especially flagellates like Chilomonas, Trachelomonas, Euglena, etc., and ciliates such as Urocentrum, Paramœcium, Bursaria, Colpoda, etc., but no attention is

paid to them. Finally, however, a particular kind of ciliate comes along, *Halteria grandinella*, which, sailing along with its graceful but spasmodic motion, suddenly finds itself on the end of one of the long tentacles of Actinobolus. The captive whirls

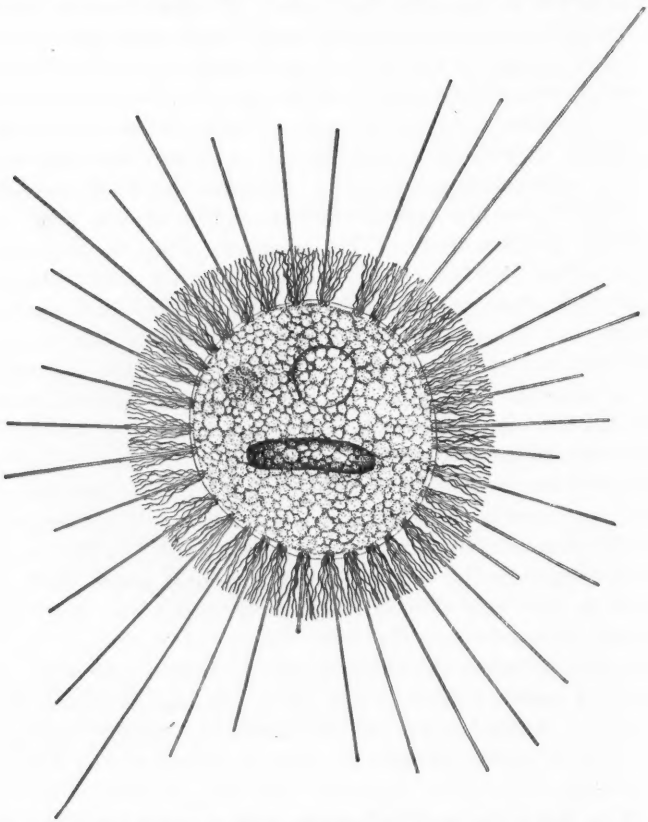


FIG. 4. — *Actinobolus radians* St. at rest, with tentacles widely outstretched, waiting for Halterias, one of which has been captured. The mouth is on the underside. × 1200.

round and round for a brief second or so, and then becomes quiet, just as it does when captured in a similar way upon the tentacles of a suctorian. The tentacle then begins to shorten, and as it shortens the victim is drawn towards the captor,

perhaps to the side, perhaps on top ; wherever the prey may be drawn, however, it is gradually worked downwards by the tentacles to the underside toward the mouth, and then with a single swallow it is transferred to the waiting endoplasm in which it is digested. So insatiable is the appetite of this form that, after adding water containing Halteria in abundance, I have seen it swallow in the manner described above no less than ten individuals within half an hour, after which its endoplasm appeared filled with foreign bodies, as Von Erlanger described in the form he observed.

This then is the function of the tentacle, a food-catching organ or set of organs ; the trichocyst which Von Erlanger described, or its analogue (I was unable to make it out as described by Erlanger), brings down the prey, and the tentacle, by shortening, fetches it to the mouth. The tentacle itself is inserted in the Halteria, for it can be seen with the greatest distinctness when the victim becomes quiet, and I believe that the dart at the end as described is not discharged into the prey but is driven into the soft body of the victim as a minute spear, with shaft attached.

When fully fed or when warmed by artificial means the animal detaches itself and draws in its tentacles. It then swims mouth first in a rambling sort of way, turning the while on its longer axis (Fig. 3).

Apart from the general biological interest which such an organism has, there is a considerable interest from a theoretical point of view. Maupas maintained in 1881 that the Ciliata have been derived from the Rhizopoda through the Suctoria, and that the tentacles are to be compared with pseudopodia, while the forms with both cilia and tentacles were considered intermediate. So important was the group of tentacle-bearing forms considered that Mereschowsky formed a special group — the Suctociliata — for their reception. Neither Maupas, Entz, nor Mereschowsky could regard the tentacles in these forms as food-taking organs similar to those of the Suctoria, and could assign them no function other than that of assisting in the capture of aliments. As well known, the tentacles in the Suctoria are for the most part hollow, and the food is taken in some manner

through the open ends. Maupas regarded them, together with the tentacles of Actinobolus, Ileonema, and Mesodinium, as pseudopodia, and thought that through them the ciliates came from the Suctoria and the latter from the Rhizopoda. This theory of the origin of the Ciliata from Rhizopoda has but an historical interest, and it is now very generally if not almost universally held that the Suctoria came from the Ciliata ; while the tentacled forms of ciliates are merely independent modifications for special ends and with no phylogenetic significance. A number of minor points suggest the close relation of the forms like Actinobolus to the Suctoria, but more careful consideration leaves little reason to doubt the view that they represent merely parallel evolution, being adaptive features for special ends.

THE MOLLUSCAN FAUNA OF THE GENESEE RIVER.

FRANK COLLINS BAKER.

THE study of faunal distribution has always been a favorite occupation of zoölogists, and particularly of those interested in the study of the Mollusca, as in this branch we find a very large number of species, covering wide areas and subject to every variation of environment. In no department of the Mollusca is this of such absorbing interest as in the fresh-water forms (unless we except, perhaps, the air-breathing pulmonates), especially those inhabiting a large river where there are several barriers to the homogeneous distribution of its shell fauna. During the past summer the writer spent several months in such a study of the Genesee River, where the environments are quite different in several parts of the stream, with a corresponding difference in the mollusk fauna. The river was carefully surveyed from near its mouth on Lake Ontario to beyond South Park, a distance of ten miles. A large collection was made, which is now in the museum of the Chicago Academy of Sciences. My thanks are due to Miss Edna E. Hall for valuable assistance in collecting, and to Rev. John Walton for many notes.

The Genesee River rises in Potter County, Pennsylvania, and flows in a generally northward direction for about 120 miles, emptying into Lake Ontario, seven miles north of Rochester, N. Y. The Genesee valley is very fertile, and the river flows between low banks rich in vegetation. Before passing Rochester the river is deep, the banks muddy, and the current steady but not very swift. From a point a little north of Genesee Valley Park (or South Park) the bottom of the river becomes very rocky, the current swift, and at Rochester the river drops to the valley below in three series of falls of considerable magnitude.

The geography of the river from South Park to the lake may be thus described: From south of Genesee Park to within a short distance of a small dam it is broad, deep on one side and affording a shelving, shallow bank on the other, the bottom being composed of a clayey mud. Unios, Campelomæ, Goniobases, Sphæria, and Physæ are here very common. Just before reaching the dam the river shallows very perceptibly, flowing rapidly over great ledges of limestone. *Lampsilis luteolus* and *L. iris* are very common here, and also Goniobasis, while Physa is not quite so common.

Below the dam, which is now broken and very much out of repair, the river flows rapidly over a rocky bed, in many places the water being so shallow that persons can wade across. The right bank is very rocky, more so than the left, and forms little sheltered bays here and there, in which Goniobasis and Physa live by thousands, the former making a veritable pavement in some places. *Lampsilis luteolus* is also common, although apparently preferring the middle of the river. Along the bank here the Unios lie in great windrows, their dead shells piled up like the débris on an ocean shore. In this pile of shells such species as *Lampsilis iris*, *L. luteolus*, *Quadrula rubiginosa*, *Lampsilis complanatus*, and *Alasmodonta rugosa* are common. The water near the rocky shore also affords good retreats for the mollusks.

Near the Erie Railroad bridge the water deepens, and the Unios begin to thin out, although *Lampsilis luteolus* seems to be as common as ever. Goniobasis also flourishes, while Physa almost dies out. Near Clarissa Street bridge the water becomes still deeper, and the only species found are *Lampsilis luteolus*, *L. iris*, *L. complanatus*, and Goniobasis, with a stray Campeloma or Sphærium. Physa seems to have disappeared completely. Below Clarissa Street bridge the water deepens to the state dam, beyond which it is very shallow and rocky, so far as known affording no mollusks save an occasional Goniobasis or Campeloma. At the dam the water is deflected in a large stream for factory uses and again reaches the river at the first falls.

At Rochester, below the bridge of the New York Central Railroad, the river drops to the valley below in a fall 96 feet in height, cutting through Niagara limestone and Clinton shale. Below this fall the current is rapid, the river flowing in a sinuous course, leaving on either side at intervals a low, flat piece of ground with a shallow, shelving shore, the opposite side, however, being very deep. The upper part of the river is so contaminated with oil and gas products from the gas works and a number of manufactories that mollusks cannot live here. A short distance down the river, where the water is not so badly contaminated, a few Physæ, Planorbis, and Limnæa live. These grow more abundant as the purer waters are reached. About two miles farther north a second fall occurs, 26 feet in height, cutting through the Clinton shale. Below this fall the river runs swiftly, is very deep, and forms a circular pool just beneath the fall. The walls are very steep and stony, the river having cut away the soft shale, leaving great projecting ledges. Physa, Planorbis, and Limnæa are here notably abundant, living on ledges of rock where the water is a few inches deep.

A few hundred feet north of this fall a third one occurs, cutting through Medina sandstone 83 feet in height, and the river drops to the valley below, flowing at first rather rapidly, but after a mile or so rather quietly, between well-wooded banks 210 feet in height. The river is here bordered by many swampy flats covered with rank vegetation, and the shores are muddy. Near the falls the river is somewhat shallow, flowing over fallen rocks, but it soon becomes quite deep. The genera present are Limnæa, Physa, Planorbis, Bythinia, and Calyculina; Limnæa and Planorbis predominating. In the mouth of the Genesee there are some eight or ten species of Unios, with some gastropods, which have come in from Lake Ontario, but they have not as yet reached far enough up the river to form a factor in this discussion.

The following table shows the comparative distribution of the species in each section of the river. An asterisk (*) indicates that the species is very abundant, while the dagger (†) shows that the species is more rarely found.

Table of Comparative Distribution.

Above First Falls.	Between First and Second Falls.	Between Second and Third Falls.	Lower River.
Planorbis trivolvis *	Planorbis trivolvis *	Planorbis trivolvis *	Planorbis trivolvis *
Limnæa palustris †		Limnæa palustris †	
	Limnæa catascopium *	Limnæa catascopium *	Limnæa catascopium *
	Limnæa caperata †	Limnæ caperata †	Limnæa caperata †
Ancylus rivularis †			
Physa integra *		Physa integra †	
	Physa sayii *	Physa sayii *	Physa sayii *
			Physa gyrina *
			Physa heterostropha †
			Bythinia tentaculata
Goniobasis livescens *			
Campeloma rufum *			
Campeloma decisum *			
Campeloma integrum †			
Calyculina transversa †			Calyculina transversa *
		Calyculina partumeia †	Calyculina partumeia †
Sphærium simile *			
Sphærium stamineum *			
Anodonta lewisii †			
Alasmodonta pressa *			
Alasmodonta rugosa *			
Alasmodonta deltoidea †			
Alasmodonta marginata †			
Strophitus edentulus *			
Anodontopsis ferussacianus †			
Quadrula rubiginosa *			
Quadrula undulata †			
Lampsilis iris *			
Lampsilis luteolus *			
Lampsilis ventricosus †			
Lampsilis alatus †			
Lampsilis radiatus †			
Lampsilis complanatus *			
Lampsilis tappanianus †			

A study of the table will show a few interesting facts. The first will be the abundance of Unios above the falls and their total absence below, showing that the upper falls afford an insurmountable barrier to their further distribution in this direction. Another fact of equal note is the abundance of certain gastropods in all four sections of the river (Planorbis, Physa). The general absence of ctenobranchiates below the falls (Bythinia excepted) is noteworthy. Bythinia is a recent addition to the fauna of the lower river, appearing in immense numbers in 1898. It was very common at the mouth of the river, in Lake Ontario, in 1895, and in these three years it became one of the most abundant mollusks in the lower river.

The distribution of Physa is also peculiar. *Physa integra* is the dominant and (so far as I know) the only form above the falls, and *Physa gyrina* below. *Physa sayii* is the only species between falls 1 and 2 and is very abundant only between the upper and lower falls, a very peculiar distribution, for which I cannot account. *P. integra* does not occur between the upper river and falls 2 and 3, and I was not able to find it between falls 1 and 2, which, if borne out by future observations, offers an interesting phase of distribution. Why *P. integra* should be so interrupted in its distribution may be accounted for by two hypotheses: (1) that specimens may have been carried over the first and second falls and found lodgment above the lower falls; or (2) specimens might have been carried by birds or other animals. Why *Physa sayii* is found everywhere except in the upper river is also an interesting question.

Limnæa seems to be evenly distributed, and yet in this genus we find the same peculiar distribution as in Physa. *L. palustris* has been collected in small numbers in the upper river, but *L. catascopium* and *L. caperata* take its place in the other three regions, the former being very abundant. Ancylus has been found only in the upper river, in the dead valves of Unios, but it may be that it inhabits all parts of the river. As in the case of *Physa integra*, we find the distribution of *Limnæa palustris* to be peculiar, jumping, as it does, the first fall and occurring sparingly between falls 2 and 3. *Planorbis trivolvis* is the only evenly distributed species. Among the bivalves,

Calyculina transversa is interrupted in its distribution, but, like *Physa gyrina, P. heterostropha,* and *Bythinia tentaculata,* may have come up the river from Lake Ontario. This, however, will hardly account for *Calyculina partumeia,* which is found in the lower river and between falls 2 and 3.

As one glances over the table the fact presents itself that there is a marked division in the faunas between the upper river and the series of falls, and the lower river. This may be accounted for by the fact that for a distance of about two miles above the first fall the river is shallow and very rocky, in fact flowing over great ledges of Niagara limestone, and the Unios all seem to prefer the deeper, more quiet waters above this section of the river, only a few stragglers, like *Lampsilis luteolus, L. iris,* and *Alasmodonta rugosa,* being found in this rocky region. The writer was unable to find Unios within a half mile of the upper falls, showing conclusively that this environment is unsuitable for them. Another reason why Unios are not found below the falls is probably that their heavy shells and also their habit of burying themselves in the mud prevent them from rising to the surface and being swept over the falls, as might be the case with Planorbis, Limnæa, or Physa, which come periodically to the surface for air.

The foregoing discussion indicates that a series of falls like those at Rochester will prove an effective barrier to the distribution of some mollusks (as the pelecypods with mud-burrowing habits and the ctenobranchs, which cling to the rocks and do not come to the surface), while to others (like the fresh-water pulmonates, which come to the surface frequently and hence could be swept over the falls) it is not a barrier. Future studies and collections, however, may modify the above conclusions.

THE CONCHOMETER.

HAROLD S. CONANT.

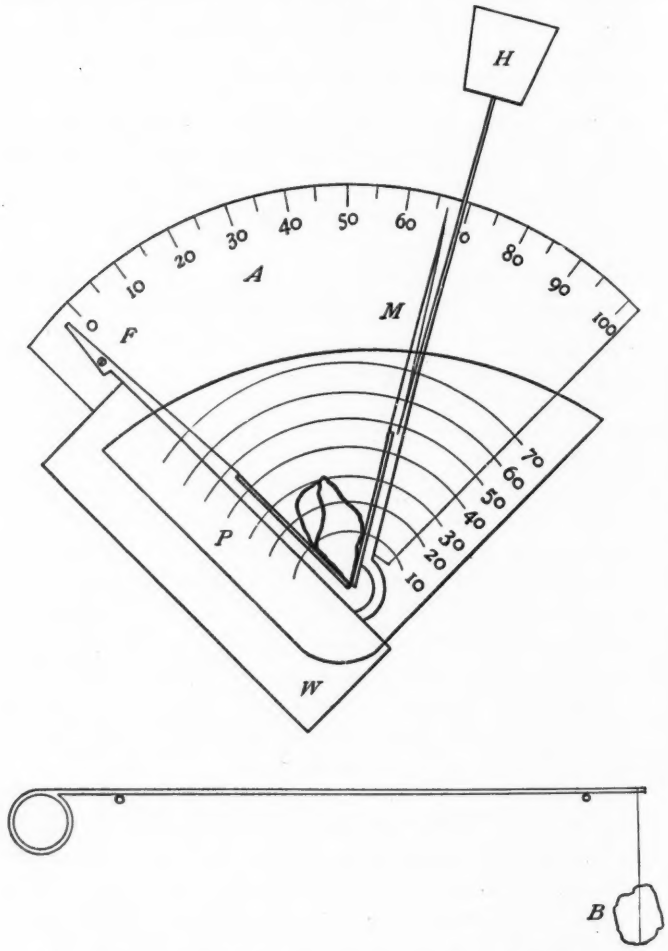
In connection with a recent study of variation in *Purpura lapillus*, it seemed necessary to measure the apical angle of the shell, among other features, and since no apparatus adapted to this purpose was known, an instrument, which I have called a *conchometer*, was constructed.

About 4000 measurements have been taken by this means; and so well did they correspond with theoretical considerations that the writer believes the value of the instrument to have been proven. With the possibility that those who are using the statistical method for studying variation may find it suited to their purpose, a description is here given.

It consists of two parts: (1) a device for measuring angles at the ends of the shell, and (2) a device for measuring the long axis of the shell and the distance from the apex of the shell to the aperture. The first consists of an ordinary drawing compass, of which one arm, *F*, is firmly attached to a board, and the other, *M*, may be moved over a graduated arc, *A*, which is also attached to the board. The arc reads to half-degrees and has its zero-point at the fixed arm. Attached to each arm of the compass is a plate of metal some 2 inches long and $\frac{3}{4}$ of an inch wide, standing vertically to the board, so that only the edge is visible in the figure. The two plates are so placed on the arms that they just touch each other at the pivot of the compass. When the board is set in position, vertically, the plates form a V whose angle may be made larger or smaller by the adjustment of the movable arm by means of a suitable handle, *H*. It is with this part of the apparatus that the apical angle of the shell may be measured, as described later.

The second part of the apparatus, by means of which linear measurements are taken, consists of two scales graduated to millimeters by means of concentric lines. One is etched upon

a glass plate, *P*, placed in front of the V, parallel to the board, and secured to it by means of a block, *W*; and the other is a ruled scale attached to the board. The lines on the second



scale are directly behind those on the glass plate and, therefore, are not seen in the figure. The two scales are exactly alike, except that one is etched on glass and the other ruled on

paper. The object of having two scales is to avoid parallax errors in reading. The paper scale is protected from dampness (and consequent warping) by a sheet of transparent celluloid.

A few words may be necessary to explain the working of the instrument. A shell of *Purpura lapillus* is lowered into the V, and the arms are adjusted to fit the apex. It is not a difficult matter to do this, and the adjustment may be made more accurately by having the plates polished to mirror-like brightness and using then the well-known method of determining contact by reflection. The shell having been well fitted, the position of the point of the movable arm may be read on the before-mentioned arc, *A*, and the apical angle be thereby determined. A simple bob, *B*, is used to lower the shell into the V and to withdraw it. This is made of stiff copper wire, with a small ball of cotton wool dangling at the end of a piece of finer wire. The cotton wool is thrust into the aperture of the shell, and in this way the latter is held firmly, apex downwards.

The total length of the shell and the distance from the apex to the aperture are both measured while the shell is in the position just described and shown in the figure. It is important to note that the zero-point of the linear scale lies at the apex of the V, and that the apex of the introduced shell must necessarily be at that point. Hence the total length of the shell will be determined by observation of the part of the shell lying farthest from the zero of the scale, and when found it may be read directly by means of the concentric lines. In the same way the distance from the apex to the aperture may be read directly by noting where the aperture comes on the scale. Care should, of course, be taken always to present the ventral side for measurement. After some practice the measurements may be taken rapidly and accurately.

Dow Academy, Franconia, N. H.

SYNOPSES OF NORTH-AMERICAN INVERTEBRATES.

XVI. The Phalangida.

NATHAN BANKS.

The Phalangida, or the Opiliones as they have been called by some authors, form a very distinct order of the Arachnida. The cephalothorax is of one piece, but often presenting one or two incomplete transverse furrows. There is also a furrow on each side, which is supposed to indicate that the portion beyond is a part of the pleura. On this part on each anterior side there is a small, somewhat circular depression, with a membranous bottom; these are called the lateral pores. On the middle line of the cephalothorax, and frequently near the anterior margin, is a rounded elevation, with a simple eye on each lateral face; this is the eye-tubercle, or eminence. The abdomen is united to the cephalothorax by the whole of its breadth, so that there is no trace of a pedicel. It is always quite broad when compared to its length, never slender, and usually quite high; in the males it is often tapering behind. There are considered to be eight segments in the abdomen, but in many forms the basal and median ones are poorly defined on the dorsum; on the venter there are usually six distinct segments. The underside of the cephalothorax is occupied by the coxæ and a median piece similar to and often called a sternum. It is, however, something quite different; it is the basal ventral segments advanced forward over the bases of the coxæ; it carries with it the opening of the genital organs, which thus, in certain forms, appears to issue close to the mouth. This advancement of the abdomen is so pronounced in many of our common forms that the coxæ are crowded at base and so appear to radiate from a central point. The legs are usually very long and slender, though tarsi and

ofttimes several of the other joints are divided into smaller portions by what are termed false articulations. Each tarsus is terminated by one or two claws.

The habits of the Phalangida are rather simple. With our common forms the length of life is but one year. The eggs are laid in the ground, or in crevices of wet or decaying wood, during the summer or fall; the young hatch in late fall or early spring. At birth they have the general appearance of

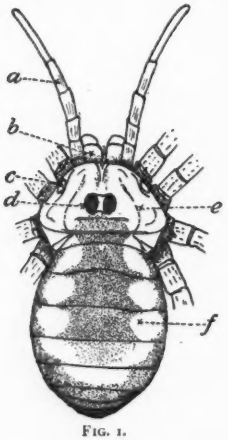


FIG. 1.

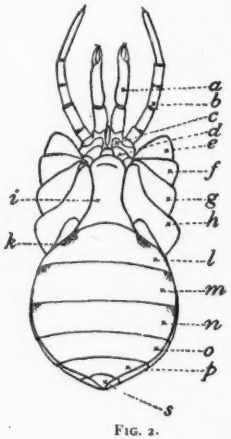


FIG. 2.

FIG. 1. — Dorsal view of a phalangid. *a*, palpus; *b*, mandible; *c*, lateral pore; *d*, eye-tubercle; *e*, cephalothorax; *f*, abdomen.

FIG. 2. — Ventral view of a phalangid. *a*, mandible; *b*, palpus; *c*, maxilla; *d*, pedal lobe; *e*, coxa I; *f*, coxa II; *g*, coxa III; *h*, coxa IV; *i*, advancement of abdomen; *k*, spiracle; *l*, 2d ventral segment; *m*, 3d ventral seg.; *n*, 4th ventral seg.: *o*, 5th ventral seg.; *p*, 6th ventral seg.; *s*, anal plate.

the adult, often, however, with slight modifications. Some species having short palpi when adult have long palpi when young. In several of our species the young have the patella of the palpus with a long branch, whereas it is absent or nearly so in the adults.

They spin no web and make no retreat of any kind. They usually move slowly, but a few can run rapidly. Some species occasionally congregate in numbers on trees. They feed mostly on living insects, but sometimes on decaying animal matter. They appear to have few enemies, but their long legs or hard

bodies are a serviceable protection. When handled they often exude a whitish fluid, which in some species has a disagreeable odor.

The points for the separation of species are often best observed in the males; this is especially true in the large genus Liobunum, in which the females are not known for several species. The males, as a rule, have more slender legs and palpi, and a more tapering abdomen; but in some species the abdomen of the male is very short and broadly truncate. In Liobunum the last joint of the male palpus shows a row of small denticles beneath. In a few forms the male has the hind coxæ enlarged. In several cases there are colorational differences between the sexes. In many forms the male is more spinose than the female. The order Phalangida is usually divided into two suborders: Mecostethi (Laniatores of Koch) and Plagiostethi (Palpatores of Koch):

First ventral segment of abdomen not reaching in front of hind coxæ; hind tarsi with two claws at tip or else with a compound claw; palpus with tibia and tarsus more or less depressed; hind legs usually the longest . . . . . MECOSTETHI

First ventral segment of abdomen extends much in front of hind coxæ; all tarsi with but one simple claw; palpus with tibia and tarsus cylindrical, second legs the longest . . . . . PLAGIOSTETHI

MECOSTETHI.

This suborder is represented in our fauna by two families:

1. Hind pair of coxæ free at apex; spiracles obscure . PHALANGODIDÆ
   Hind coxæ wholly united to the venter; spiracles distinct COSMETIDÆ

The Cosmetidæ have but one genus, Cynorta, of three species, in the United States; they can be distinguished as follows:

1. Two acute spines near end of dorsal shield . . *C. ornata* Say (Fla.)
   Two rounded tubercles instead of spines . *C. sayii* Sim.[1] (S. States)
   Neither spines nor tubercles; body with two pale spots above
   C. bimaculata Banks (Calif.)

Our Phalangodidæ are arranged in four genera:

1. One compound claw to each of the four posterior tarsi; palpi not as long as the body; eyes present . . . . . Sclerobunus
   Two simple claws to each posterior tarsus 2

[1] Includes *C. albolineatus* Sœrensen.

2. Eye-tubercle arising from anterior margin of the cephalothorax; palpi shorter than the body . . . . . Sitalces
Eye-tubercle arising back from the margin; palpi longer than body . 3

3. Tarsus II about twice as long as body, its joints very slender; no eyes Phalangodes
Tarsus II about length of body; eyes often present . . Scotolemon

SCOTOLEMON Lucas:

1. Eye-tubercle ends in a spine; second joint of palpus three times as long as wide; body with short, stout spines . *S. spinifera* Pack. (Fla.)
Eye-tubercle without spine; second joint of palpus about twice as long as broad 2

2. Tarsus II with short joints; palpi stouter *S. flavescens* Pack. (Ky., Ind., Va.)
Tarsus II with joints slender; palpi more slender *S. californica* Bks. (Calif.)

SCLEROBUNUS Banks:

Color red, tips of legs black . . . . *S. robustus* Pack. (W. States)
Color brown, tips of legs yellowish *S. brunneus* Bks. (Wash., Alaska)

SITALCES Simon . . . . . *S. californica* Bks. (Calif.)

PHALANGODES Tellkampf. . . . *P. armata* Tellk. (Mammoth Cave)

PLAGIOSTETHI.

Three families occur in the United States:

1. Last joint of palpus with a claw at end, this joint longer than preceding one (except in male of Protolophus) . . . PHALANGIDÆ
Last joint of palpus much shorter than penultimate, no claw at its tip . 2

2. Palpi very short, concealed under the projection of eye-tubercle TROGULIDÆ
Palpi long and prominent . . . . . NEMASTOMATIDÆ

Our genera of Phalangidæ are separated as below:

1. Male with palpus enlarged, last joint shorter than penultimate; female with patella of palpus provided with a long branch; palpal claw smooth; a row of teeth on sides of coxæ . (Protolophini) Protolophus
Last joint of palpus longer than penultimate; patella without branch in adult 2

2. Eye-tubercle of enormous size, three long spines on femur of palpus (Caddini) Caddo
Eye-tubercle of normal size 3

3. A group of spinules on anterior margin of the cephalothorax and the eye-tubercle spinose; palpal claw smooth, rarely if ever with lateral rows of teeth on coxæ, frequently with spines on femur of palpus (Phalangini) 10

Eye-tubercle smooth, if spinose then no group of spinules on anterior margin of the cephalothorax 4

4. Palpal claw denticulate, a row of teeth (adult) on sides of coxæ, distinct at least on anterior side of coxa I, legs usually long . (Liobunini) 5

Palpal claw smooth, no such rows of teeth on coxæ, legs usually shorter . . . . . (Leptobunini) 7

5. Body very hard and granulate above and below; legs very short, fourth pair nearly as long as second pair . . . . . Mesosoma

Body softer, although often subcoriaceous; rarely granulate below; legs longer, fourth pair much shorter than second pair 6

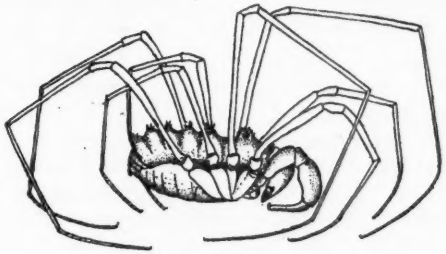


FIG. 3. — *Protolophus singularis.*

6. Femur I longer than body or in some females a little shorter, but longer than width of body . . . . . Liobunum

Femur I shorter than body, in females not as long as width of body Hadrobunus

7. Inner margin of patella extended; body very hard and rough; eye-tubercle spinose: coxæ III and IV in males enlarged. Trachyrhinus

Inner margin of patella not extended, or at least the body quite soft 8

8. Legs slender and long as in Liobunum, coxa II not shut out by I and III . . . . . Leuronychus

Legs much shorter, femora I thickened or not as long as width of body; eye-tubercle smooth 9

9. Femora and tibiæ I and III thickened; coxa II shorter than I Eurybunus

Femora and tibiæ I and III not thickened; coxa II about as large as I . . . . . Leptobunus

10. Femur of palpus provided with prominent spines 11

No such prominent spines 12

11. No false articulations in metatarsus I; eye-tubercle more remote from anterior margin . . . . . Lacinius

At least one false articulation in metatarsus I; eye-tubercle nearer to margin . . . . . Oligolophus

12. Femora and tibiæ I and III thickened; coxa II completely shut out by I and III . . . . . Globipes
Femora and tibiæ I and III normal; coxa II not shut out by I and III 13
13. Two prominent supra-mandibular teeth; dorsum punctate Homolophus
No such teeth 14
14. Femur I longer than width of body . . . . . Phalangium
Femur I shorter than width of body . . . . . Mitopus

PROTOLOPHUS Banks:

Abdominal tubercles unarmed . *P. tuberculatus* Bks. (Calif., Tex.)
Abdominal tubercles with a few spinules, male palpi larger. *P. singularis* Bks. (Calif.)

CADDO Banks . . . . . *C. agilis* Bks. (N. Y., D. C.)

PHALANGIUM Linné:

Palpi very long, in male longer than body, in female longer than width of body; the second joint of male mandible is prolonged above in a spur . . . . . *P. longipalpis* Weed (Ark.)
Palpi much shorter, in female scarcely as long as width of body; no spur on mandibles of male . . . *P. cinereum* Wood (N. States)

MITOPUS Thorell:

1. Tibia II is much longer than metatarsus II; one false articulation in metatarsus I; eye-tubercle about its diameter from anterior margin *M. californicus* Bks. (Calif.)
Tibia II is subequal to or shorter than metatarsus II 2
2. Gray and white, no false articulation in metatarsus I *M. dorsalis* Bks. (Alaska)
Brown or black and white, two false articulations in metatarsus I *M. montanus* Bks. (N. H.)

LACINIUS Thorell:

Metatarsi I and III banded in middle; spines at tips of femora and patellæ very prominent . . . . . *L. texanus* Bks. (Tex.)
Metatarsi I and III unbanded; legs longer, spines at tips of femora and patellæ less prominent . . . *L. ohioensis* Weed (E. States)

OLIGOLOPHUS Koch . . . . . *O. pictus* Wood (N. E. States)

HOMOLOPHUS Banks . . . . . *H. biceps* Thor.[1] (Colo. to Wash.)

GLOBIPES Banks . . . . . *G. spinulatus* Bks. (Calif.)

LEPTOBUNUS Banks:

Apices of coxæ dark, tibia I with one dark band, palpus lineate with brown . . . . . *L. borealis* Bks. (Alaska)
Apices of coxæ pale, tibia I with two dark bands, palpus not lineate *L. californicus* Bks. (Calif.)

[1] Includes *H. punctatus* Bks.

EURYBUNUS Banks:

Body smooth; leg IV nearly as long as II . *E. brunneus* Bks. (Calif.)

Body with transverse rows of spinules; leg IV much shorter than II *E. spinosus* Bks. (Calif.)

TRACHYRHINUS Weed:

Coxæ pale, maculate with brown, legs mostly pale *T. marmoratus* Bks. (N. Mex.)

Coxæ unicolorous, legs mostly black . . . *T. favosus* Wood (Colo.)

LEURONYCHUS Banks:

Body with a brown dorsal vitta, patellæ of legs brown lineate with white . . . . . *L. pacificus* Bks. (Calif., Wash.)

Body without vitta, patellæ not lineate . . *L. parvulus* Bks. (Wash.)

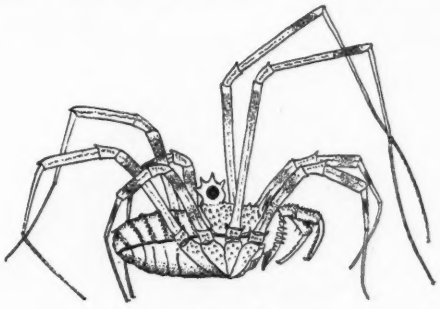


FIG. 4. — *Lacinius texanus*.

LIOBUNUM Koch. *Males:*

1. A distinct spur on the femur of palpus, dorsum yellowish, without stripe, trochanters concolorous with coxæ *L. calcar* Wood (N. States)

   No such spur 2

2. Palpus, except tarsus, mostly black 3

   Palpus yellowish or brownish 4

3. Dorsum dark, often with two large pale spots behind, trochanters usually pale . . . . . *L. exilipes* Wood (W. Coast)

   Dorsum pale yellowish, no stripe, trochanters and bases of legs black . . . . . *L. nigripalpi* Wood (E. States)

4. Femur, patella and tibia of palpus plainly incrassate, dorsum with a black stripe, trochanters dark brown . *L. crassipalpis* Bks. (D. C.)

   Palpal joints not incrassate 5

5. Femur of palpus very long, curved, extending much above surface of cephalothorax, dorsum with a distinct black stripe, trochanters black . . . . . *L. vittatum* Say [1] (U. S.)

[1] Includes *Liobunum dorsatum* Say.

Femur of palpus shorter, dorsum without distinct black stripe . . . 6

6. Dorsum dark, with two large yellowish spots on union of cephalothorax and abdomen . . . . . *L. bimaculatum* Bks. (Calif.)

Not so marked 7

7. Apex of tibia II white, trochanters black, body short *L. longipes* Weed (E. States)

Apex of tibia II not white 8

8. Apex of femur I white, preceded by a black band, coxæ pale outside . . . . . *L. townsendi* Weed (N. Mex., Tex.)

Femur I not so marked 9

9. Trochanters dark, contrasted in color with the coxæ 10

Trochanters pale, concolorous with coxæ 14

10. Legs black, dorsum dark brown, eye-tubercle slightly spinulate *L. nigripes* Weed (Ohio)

Legs pale, sometimes marked with black 11

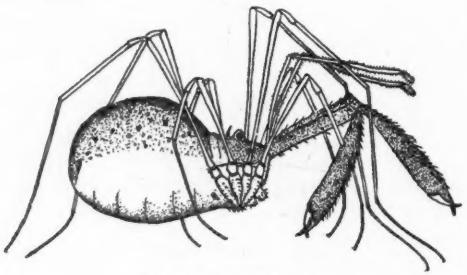


FIG. 5. — *Taracus pallipes.*

11. Femur I barely as long as body, tips of femora and tibiæ dark brown or black, eye-tubercle nearly smooth *L. formosum* Wood (E. States)

Femur I plainly longer than body, eye-tubercle spinulate, legs not so distinctly marked with black 12

12. Abdomen tapering behind, dorsum golden, base of femora not black, trochanters dark brown, of moderate size *L. verrucosum* Wood (N. Y.)

Abdomen rather short and broad, legs very long, small species . 13

13. Dorsum and trochanters light brown, bases of femora not black *L. bicolor* Wood (S. States)

Dorsum yellowish, trochanters and bases of femora black *L. speciosum* Bks. (Ala.)

14. Body short and broad, femur IV often black at base, small species *L. politum* Weed (E. States)

Body tapering behind, femur IV not black at base, larger species 15

15. Extremely spinose beneath, an impressed line on last ventral segment, large species . . . . . *L. flavum* Bks. (S. States)

Moderately spinose, rather granulate, no impressed line, moderate size . . . . . *L. ventricosum* Wood (E. States)

HADROBUNUS Banks:

Dorsum finely spinulate; legs longer, in female not much marked with brown at tips of joints . . . . . *H. grande* Say (E. States)

Dorsum more smooth, with many small, round, pale spots; legs shorter, more marked with brown *H. maculosum* Wood (S. States)

MESOSOMA Weed . . . . . *M. niger* Say (S. States, Neb., Dak.)

The Nemastomatidæ include three genera, which can be separated as below:

1. Mandibles longer than the body, projecting forward (Ischyropsalinæ) Taracus

Mandibles shorter than body, directed downward . (Nemastominæ) 2

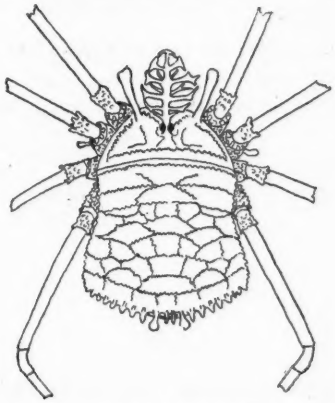


FIG. 6. — *Dendrolasma mirabilis.*

2. Fourth joint of palpus much thickened . . . . . Phlegmacera

Fourth joint of palpus scarcely thickened . . . . . Nemastoma

PHLEGMACERA Packard:

1. Several false articulations in femora III and IV, eye-tubercle very broad . . . . . *P. bryantii* Bks.[1] (Alaska)

No false articulations in femora 2

2. A pair of prominent erect spines on the anterior part of the abdomen . . . . . *P. occidentalis* Bks. (Wash.)

No such spines . . . . . *P. cavicoleus* Pack.[2] (Ky., N. Y., N. H.)

[1] Includes *Tomicomerus bispinosus* Pavesi.

[2] Includes *Sabacon spinosus* Weed.

NEMASTOMA Latreille:

1. Fourth joint of palpus less than twice as long as the fifth
N. inops Pack. (Ky.)
Fourth joint of palpus twice as long as the fifth 2
2. Dorsum with some spines . . . . *N. modesta* Bks. (Calif., Wash.)
Dorsum without spines . . . . . *N. troglodytes* Pack. (Utah)

TARACUS Simon:

1. Dorsum of abdomen spinose, mandibles pale in color
T. spinosa Bks. (Calif.)
Dorsum of abdomen smooth, mandibles dark 2
2. Mandibles smooth . . . . . *T. pallipes* Bks. (Wash.)
Mandibles rough, very distinct spines on basal joint
T. packardi Sim. (Colo., N. Mex.)

The Trogulidæ in our fauna is represented by but two genera, both restricted to the Pacific slope:

1. Eye-tubercle projecting in the form of a spoon, two spines at each side on the anterior margin . . . . . Ortholasma
Eye-tubercle branched, a single club at each side on the anterior margin . . . . . Dendrolasma

ORTHOLASMA Banks . . . . . *O. rugosa* Bks. (Wash.)
DENDROLASMA Banks . . . . . *D. mirabilis* Bks. (Calif., Wash.)

PRINCIPAL WORKS ON PHALANGIDA.

BANKS, N. The Phalangida Mecostethi of the United States. *Trans. Amer. Ent. Soc.* Vol. xx (1893), pp. 149–152.

——— The Phalanginæ of the United States. *Can. Entom.* (1893), pp. 205–211.

——— The Nemastomatidæ and Trogulidæ of the United States. *Psyche* (1894), pp. 11, 12; 51, 52.

WEED, C. M. A Descriptive Catalogue of the Harvest Spiders (Phalangiidæ) of Ohio. *Proc. U. S. Nat. Mus.* Vol. xvi (1893), pp. 543–563, 12 pls.

——— New or Little-Known North-American Harvest Spiders. *Trans. Amer. Ent. Soc.* Vol. xix (1892), pp. 187–194, 7 pls.

WOOD, H. C. On the Phalangeæ of the United States of America. *Commun. Essex Inst.* Vol. vi (1868), pp. 10–40.

PRINCIPAL WORKS ON SCORPIONS, SOLPUGIDS, AND PEDIPALPI.[1]

KRAEPELIN, K. Revision der Scorpione. *Jahrb. Hamburg.* Teil I, Bd. viii (1891), pp. 1–144; Teil II, Bd. xi (1894), pp. 1–248.

——— Scorpiones und Pedipalpi. *Das Tierreich*, 8. Lieferung (1899), pp. 1–265.

PUTNAM, J. D. The Solpugidæ of America. *Proc. Davenport Acad. Nat. Sci.* Vol. iii (1882), pp. 1–149, 4 pls.

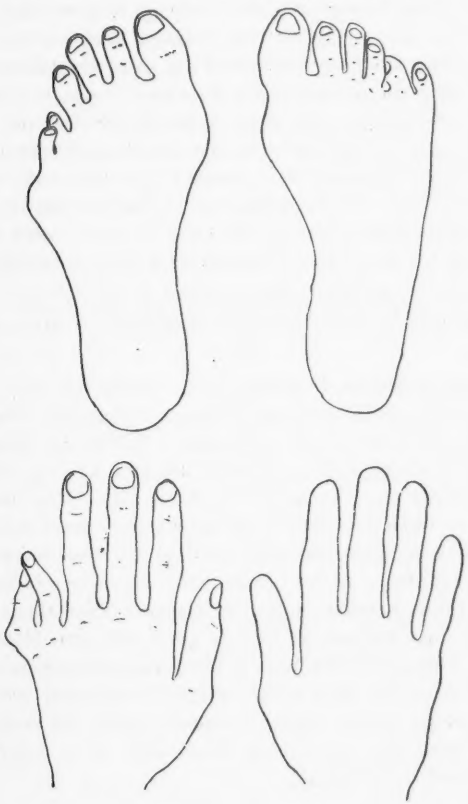
WOOD, H. C. Descriptions of New Species of North-American Pedipalpi. *Proc. Acad. Nat. Sci. Philadelphia* (1863), pp. 107–112.

——— On the Pedipalpi of North America. *Journ. Acad. Nat. Sci. Philadelphia.* (2.) Vol. v (1863), pp. 357–376.

[1] This list was omitted in Synopsis IX.

VARIATION NOTES. — Nos. 4–6.

4. **A Case of Polydactylism.** — A number of years since, a case of polydactylism attracted my attention, and in view of the value of



records of such cases I have decided to offer an account of the facts as known to me. The case was that of a young man twenty-five years of age, a student in Hamline University. The accompanying

drawings are tracings made by running a pencil around the outlines of the feet and hands. The right hand is entirely normal. The left hand varies as to the little fingers, there being two digits. A careful manipulation of the palm showed that there is a single metacarpal at the base, and distally two digits, each with three bones; the bones are entirely separate, though the skin grows across between them on the level of the proximal joint. Both of the feet are six-toed, the ulnar digit in each being doubled. This doubling was found, by feeling through the skin, to begin with the digit, the metacarpal being single. The left foot bears a lump on the outside at the base of the outer digit, seemingly due to an irregularity connected with the variation presented by the toes. I was told that it had been there from before the time of fitting the first pair of shoes. There was no knowledge of a similar condition of the digits in the family; the grandparents were personally known to the young man and nothing like it had been remarked among his relatives.

The case appears to fall in the class of cases noted by Bateson ("Materials for the Study of Variation," p. 345) as among the commonest forms of polydactylism, in which there is an extra minimus, the metacarpals and metatarsals being normal.

H. L. OSBORN.

5. **Pedigree Mouse Breeding.**[1] — V. Guaita has bred white and walzing mice through seven generations. There has been a loss of fecundity, due to too close inbreeding. Tables are given showing the ancestry of about three hundred mice of varying colors. The author does not make sufficient use of his data. The most striking fact is that when pure-bred white mice were crossed with pure-bred walzers (chiefly black and white), all of the twenty-eight progeny were gray, or like a house mouse, and none were walzers. When these were bred together, nine color classes at once appeared, including albinos and walzers, as well as grays and gray-blacks. If the results of breeding in the later generations are compared with what one should expect from Galton's law of ancestral inheritance, it results that the albinos appear unusually stable and prepotent. On the other hand, the walzing condition seems to be unstable and to be less potent than normal.

[1] Von Guaita, G. Zweite Mittheilung über Versuche mit Kreuzungen von verschiedenen Hausmausrassen, *Berichte d. naturf. Ges. Freiburg*, Bd. xi, Heft 2, pp. 131–138, 1899.

6. **The Long-Tailed Field Mouse**[1] (*Mus sylvaticus*) has a distribution which is almost coterminous with the limits of the Palearctic Region; hence is a "wide-ranging species" in Darwin's sense. It is also an old species, for its bones are found in the cave deposits. It is much less variable than many other small mammals, and sports especially are rare. Thus it is a case against Darwin's law of the great variability of wide-ranging species and for Sedgwick's law of loss of variability in an old species. However, albinos (with pink eyes) have been noted as rare sports. The prevailing color is white below and more or less rufous above. Since the young are more like the house mouse in color, this color may be considered ancestral. The adult mouse becomes small and dark in certain isolated maritime localities (Lewis, Skye, Galway, and Kerry); a variation paralleled by that of squirrels, cattle, birds, the slugs, Limax, and butterflies. The mouse becomes rich-colored as it approaches the Oriental Region, — the home of rich-colored birds, — for example, at Kuatun. It is bright, clear-colored in the cold, drier regions of central Europe, just as the squirrel and red-backed vole are.

[1] Barrett-Hamilton, G. E. H. On Geographical and Individual Variation in Mus sylvaticus and its Allies, *Proc. Zoöl. Jour.*, pt. ii, pp. 387–428, London, August 1, 1900.

REVIEWS OF RECENT LITERATURE.

PHYSIOLOGY.

Heliotropism. — In this paper Holt and Lee [1] are chiefly concerned with a theoretic discussion of the nature of the responses of organisms to light; but they present, also, in support of their theory, the results of some experiments with Stentor Cœruleus, a species of Lynceus, and some fresh-water planarians. The title of the paper, "The Theory of Phototactic Response," is misleading, since the term "phototactic" is used, not in the ordinary sense, but as including those responses which have been called photopathic. In the present state of our terminology "heliotropic" would be a better term.

Intensity of light and direction of ray have been championed for half a century as the important factors of light as a stimulus: at one moment "direction" has been emphasized, at another "intensity." The present writers maintain that light acts only by its intensity, the direction of the ray being a secondary factor and one, furthermore, of an entirely different nature. Their theoretic discussion centers about the views of two prominent physiologists, Loeb and Verworn; and Verworn's theory is accepted as adequate for the explanation of all responses to light. Loeb is characterized as a believer in the importance of "direction," and Verworn in that of "intensity," but it is observed that their theories are not contradictory. So far as the exposition of these two theories, as given in the text, is concerned one seems just as applicable to the facts in question as the other, the only difference being that Loeb has sometimes used the term "direction" when intensity is evidently the determining factor, thus in appearance giving emphasis to the importance of direction, while Verworn has in all cases expressed himself in terms of intensity.

The facts of response to light, admitted as such by Holt and Lee, are three: (1) orientation in the axis of the ray, (2) positive or negative movement, (3) random movement. In explanation it is assumed that animals which show these three phases of reaction have

[1] Holt, Edwin B., and Lee, Frederic S. The Theory of Phototactic Response, *Amer. Journ. Physiol.*, vol. vi, pp. 460–481, January, 1901.

an optimum intensity in which they are not directed by the light but move at random. Below this is the sub-optimal and above it the supra-optimal. An animal in either the sub- or supra-optimal intensity is oriented by the rays so that symmetrical points of the body are equally stimulated; this is, of course, accomplished by the placing of the longitudinal axis of the organism in the axis of the ray. And whether an animal orients itself with head toward or away from the source of light (*i.e.*, whether it is positively or negatively phototactic) depends upon the physiological condition of the animal and the intensity of the light. By sub-optimal intensities organisms are supposed to be directed toward the light through the expansion of those motion-producing elements which are on the side most strongly stimulated; hence there results from this kind of orientation a positive reaction. The same organism, if in a supra-optimal intensity, will be oriented with head away from the light, because in this case contraction instead of expansion is caused, and the reaction will be negative. The orientation theory has been very clearly stated by both Loeb and Verworn.

Several different kinds of reactions, representatively selected, are explained by the writers by their theory; among them is the case of a positively phototactic animal moving toward the source of light into a less intensely illuminated region. This reaction has been taken heretofore as evidence of the independent influence of "direction" of ray. It is clearly shown in the present paper, however, that such a contention is probably false, for difference in intensity and the angle at which the organism strikes the side of the vessel are sufficient to explain the observed courses taken under such conditions.

That light acts through intensity alone is a conclusion which this paper makes plausible, but it scarcely justifies the unconditioned statement that it *does not* act by the course which the rays take through the organism. Such a reaction as the reversal of response observed by Towle in Cypridopsis and by Yerkes in Daphnia and Cypris is not easily explained by the hypothesis under consideration. The paper is valuable in that it makes clear the importance of intensity and at the same time indicates the danger of confusion in using direction as a causal term, although intensity does in part depend upon it.

R. M. Y.

Notes. — The chief defects of laboratory guides arise from the difficulty of giving sufficient directions to the student without supplying him with information that he should get from laboratory

study. This is the principal failing in Brown's *Physiology for the Laboratory* (Boston, Ginn & Co., 1900, viii + 167 pp.), which, however, is so well balanced in other respects that it deserves to be in the hands of the teacher if not in those of the pupil.

Kelly (*Jena. Zeitschr.*, Bd. XXXV, p. 429) has pointed out that calcic carbonate occurs in nature in five forms: calcite, aragonite, ktypeite, conchite, and amorphous calcium carbonate. Of these calcite and conchite are the only ones found abundantly in organisms. Conchite is probably slightly more soluble, harder, and has a higher specific weight than calcite. Both forms occur throughout the animal series; thus calcite is the mineral component of the shells of echinoderms, brachiopods, crustacea, bryozoa, of the calcareous spicules of sponges, of the ear stones of fish and amphibia, and of the eggshells of mollusks, most reptiles, and birds; conchite is characteristic of the skeletons of most stone corals, and the shells of many mollusks.

Steinach and later Magnus have shown that the iris of a frog's eye will contract when stimulated by light, even after the eye has been removed from the animal. Steinach believed this to be due to the direct action of light on the sphincter muscle; Magnus attributed it to a short nervous reflex arc within the eye. Guth (*Archiv ges. Physiol.*, Bd. LXXXV, p. 119) finds that frog eyes show this reaction fully two weeks after their removal from the animal,—a period much longer than that during which other organs containing reflex arcs, like the intestine, remain active. Moreover, pieces of the edge of the iris as well as minute isolated groups of muscle fibres from the sphincter pupillæ contract on illumination. As the latter were shown on microscopical examination to contain no ganglion cells, it must be admitted that Steinach's contention that the muscles of the iris are capable of being stimulated directly by light is correct.

BOTANY.

Recent Papers on Algæ. — (Comère, Joseph. *Les Desmidées de France*, Paris, 1901, 222 pp., 16 pls.) In the introduction the author states his double purpose in writing this work; first, to give as full an account as possible of our present knowledge of the desmids; second, a manual for the study and determination of the French

species. The first chapter deals with structure and physiology, the second with methods of collection, preparation, and study; then is a historical sketch, with bibliography, dealing with France only. Chapter 4 occupies the greater part of the book, giving the general principles of classification, followed by description of all known French species and forms. A table showing the distribution in the different provinces of France and a list of all works cited complete the text. There are sixteen plates, containing over eight hundred figures.

It is somewhat singular, considering how much of our best algological work is done by French writers, that there has never been any general systematic work on French algæ, such as Harvey's *Manual* or *Phycologia* in Great Britain, Hauck's *Deutsches Meeresalgen* in Germany, and similar works in other countries. This seems to be the first work treating of algæ, covering the whole of France, and giving descriptions of all the species mentioned. It must certainly be of much use to French students.

The classification follows in general that used by De Toni in the *Sylloge Algarum*, but with some modifications. The tribe Docideæ is united with the Closteriæ, while the Micrasteriæ retain only the forms with chromatophores as parietal disks, the forms having radial chromatophores forming the tribe Cosmariæ. The form of the chromatophores is recognized as of value in classification, but the author does not give it the value attributed by Gay.

A scientific work written by a Frenchman always has one great advantage, the "inexorable clearness" of the language; moreover, a French author apparently does not feel that a good style of writing will cast doubts on his scientific thoroughness or soundness. These merits the work in question has, and also the French predilection for symmetry; the description is a description, the note a note, and one does not run into the other; history does not intrude into physiological discussion, nor bibliography into directions for collecting.

The plates are clear, every species described being represented, mostly by camera drawings by the author. In nearly every case a colored figure is given to show the appearance of the living plant, and a line drawing to show the markings of the empty cell. Only two scales of magnification are used, 200 and 300, and the same scale is used in all the species of a genus, which is very convenient for comparison. There is an index, both of accepted names and of synonyms.

The descriptions are sufficiently full, and appear to be accurate; occasionally a word is used in a sense that might be misleading, as on p. 21, where certain desmids are said to occur "en parasites," on Sphagnum, etc. Full references are given to French authors, and a considerable number to foreign works, but the English language seems to offer great difficulties to M. Comère, as it has to many others of his nation. There are many references to Wolle's *Desmids of the United States*, and this work, with three papers published in the *Torrey Bulletin*, appears in the bibliography. It is fair to assume that M. Comère must have seen the book, but both in references and bibliography the name is "Woole." Quite curiously, at p. 98 there is a reference to another *Torrey Bulletin* article, which does not appear in the bibliography, and in this one place the name is properly spelled, "Wolle." "*Dysphynctium Thwatesii*," with synonym "*Calocylindrus Twatesii*," at p. 92, and "Twaites," p. 130, represent three attempts on the name of a well-known botanist. "Barcker in Quartely Journal, p. 208," is an interesting combination. A certain amount of carelessness in proofreading is noticeable here and there: in the bibliography Reinsch is followed by a period, as if an abbreviation, while Schaarschm has no period, though it represents Schaarschmidt. Sutarastrum, *Closterium monoliferum* are similar cases. But let him that never overlooked an error on a proofsheet cast the first stone at M. Comère.

The work makes no innovations and does not claim to add largely to previous knowledge, but it puts in small compass, and in shape convenient for the student, what otherwise would have cost him much time and trouble. Any work doing this is valuable. The nomenclature is eminently conservative; no new species is proposed, nor is any one transferred from one genus to another; the author must have nobly resisted the temptation to attach his name to something.

(Kjellman, F. R. "Om Floridé-Slägtet Galaxaura dess Organografi och Systematik," *Kongl. Svenska Vetenkaps Akademiens Handlingar*, Bandet XXXIII. Stockholm, 1900. 109 pp., 20 pls.) The genus Galaxaura, of which this paper treats, has its home in tropical and subtropical waters, the broad belt occupied by it extending quite around the world, its northern limits being near the straits of Gibraltar and on the coast of Florida in the Atlantic, Mexico and Japan in the Pacific. In the southern hemisphere it reaches similar latitudes.

In Engler and Prantl's *Naturfamilien Pflanzen* the genus is noted as having about twenty species, many of them little understood. In examining the forms from Japan, collected by the Vega expedition and subsequently by Petersen, Dr. Kjellman found many that could not be placed under known species, and was led to make a thorough study of the genus. The result of this study may be seen in the fact that, of the sixty-two species here recorded, only sixteen are of previous authors; the remaining forty-six are new.

Habit characters, on which the previous classification was almost entirely based, are here considered as of little value, and structural characters are used instead, the descriptions being supplemented by nineteen quarto plates of anatomical drawings by the author, while a double plate gives habit figures, photographically produced from herbarium specimens. The rich collections of Areschoug, Agardh, and the author himself, with those in the Swedish museums, formed the material on which the work is based, and the fact that it was all dried material in herbaria constitutes the one possibly weak spot in the results. The ideal method of study would be to see all the species in their homes, to notice the range of variation of a species in different local conditions and at different seasons, and then, with the results of this study clearly in mind, to refer to the original types. But when this study of living material must be made over half the surface of the globe, or at least the seacoast within that area, it is evident that this ideal is hardly likely to be attained.

In the tables showing the distribution of the species, only three are assigned to the coast of the United States, *G. flagelliforme*, *G. stellifera*, *G. umbellata*. This number will have to be increased, as on the shores of Florida there occur *G. obtusata*, *G. rugosa*, *G. lapidescens*, and *G. marginata*. The last two species, in the older sense, are divided by Kjellman into several species each, so that the figure for our coast must be seven, and may be one or two more.

The descriptions of the new species and the explanations of the plates are in Latin; the rest of the work, including all the historical notes and the anatomical studies, are in Swedish, which is unfortunate in a work of such general scope and interest.

(Svedelius, Nils. "Studier öfver Östersjöns Hafsalgflora," *Akademisk Afhandling*. Upsala, 1901.) The author has made a careful study of the red, brown, and green algæ of the eastern and northern part of the Baltic Sea. The flora is quite a limited one, only fifty-six species being enumerated, there being a steady falling off in the

number of species to be found as we pass from the German Ocean and along the Baltic to the Gulf of Bothnia. There is a steady reduction in the saltness of the water in this direction until at last it is almost imperceptible. Moreover, the east and west sides of the Baltic have differing degrees of salinity, and sudden changes in this, as also in the temperature, are produced by winds, conditions quite unfavorable to the existence of most marine algæ; hence the poverty of the flora.

Two elements appear to compose the flora, an Atlantic and an Arctic, but without any sharp division line. Four species, one of them new, *Ascocyclus affinis*, are considered endemic, thirty-five are characteristically Atlantic, seventeen characteristically Arctic. Most of the species appear in somewhat reduced or depauperate forms, in comparison with normal conditions. This is not the case with the green algæ, however, which are fully as well developed as elsewhere; not unnaturally, as the green algæ are largely fresh-water plants, the red and the brown being specially marine. As in the Arctic regions, some species cover considerable areas of bottom in loose-lying masses, not attached to any substratum, new growth continually forming as the old decays. These detached individuals are uniformly sterile, as is the case in the Arctic Sea, and also with the vast floating masses of Sargassum in the Atlantic. Green algæ are predominant in the upper littoral region, brown in the lower littoral, and red in the sublittoral, in about the same proportions as in the Atlantic.

There are a number of illustrations, mostly habit illustrations, among them a number of forms of *Fucus vesiculosus*, and transitions between forms; since names have been given these forms, it is perhaps well to illustrate them, but it is doubtful if they can be considered as at all well defined. It is usual to include under *F. vesiculosus* all dicœcious forms with vesicles, as well as those that look as if they ought to have vesicles. It is not unlikely that more than one species may be here included, but we are not yet in a position to draw the lines.

The work is in Swedish, which is perhaps natural under the circumstances of its issue, but like Kjellman's work previously noted, it is not easy of use by the majority of botanists.

(Børgesen, F. Freshwater Algæ of the Færöes. From the *Botany of the Færöes.* Copenhagen, 1901.) Together with Mr. Børgesen's paper on the algæ, there are printed E. Warming's "Historical

Notes on the Botanical Investigation of the Færöes," and C. H. Ostenfeld's "Notes on Geography, Climate, Topography, Geology, and Industrial Conditions." Mr. Ostenfeld's notes are furnished with excellent illustrations, so that we reach Mr. Børgesen's list of the algæ with a good understanding of the conditions that have made the flora what it is. This flora must have been introduced since the last glacial epoch, and, according to the writer, it is probably more than anything else the birds that have gradually contributed the various fresh-water algæ found on these eighteen rocky islands, only five of which have an area of over 100 kilometers each. In their migrations through Great Britain to the Arctic region the birds make a stop on these islands, the distance from the northernmost British isles being only a two hours' flight. So we find two elements in the Færöe flora, a southern, agreeing with that of Great Britain, and including some forms supposed to be peculiar to the latter, and an Arctic element; the one brought by the spring migration, the other by the return in autumn.

In all, 323 species are enumerated, beside many varieties and forms. The desmids, with 175 species, constitute more than half of the whole, — the other green algæ number 103; there are forty-one Cyanophyceæ; one Nitella, one brown alga, *Hydrurus fœtidus*, and one red alga, *Chantransia hermanni*, complete the list.

Two species of Enteromorpha, *E. compressa* and *E. micrococca forma subsalsa*, were found in brooks at a height of 200–300 meters. The former has been considered exclusively marine, the latter has been found in brackish pools in the Arctic regions; their occurrence in running fresh water is quite noteworthy. Beside several new varieties and forms, two new species are described, *Euastrum lyngbyei* and *Cladophora lyngbyei*; a plate of the latter, however, shows a form of branching which hardly accords with Cladophora; it would seem as if the plant belonged rather in Siphonocladus.

There are four good plates and an excellent map, and the whole is in unexceptionable English.

(Hirn, Karl E. "Monographie und Iconographie der Oedogoniacien," *Acta Societatis Scientiarum Fennicæ*. Helsingfors, 1900.) This volume of 400 quarto pages and sixty-four plates is a notable addition to the working tools of the systematic algologist. One hundred and ninety-nine species of Œdogonium, forty-four of Bulbochæte, and one of Œdocladium are composed in the family. Full diagnoses of all the species, with their many varieties and forms, are

given in Latin, and there is an elaborate key to the species in the same. The detailed notes under the species, as well as the general chapters, are in German. These general chapters give a full résumé, with illustrations in the text, of the structure, development, and physiology of the Œdogoniaceæ. Description, measurements, synonyms, and localities are given in ample detail, and the plates represent all the species and forms. The figures are in outline, and were drawn by the author from nature; all are of the same scale, 300/1, except a few details requiring a higher scale, and one habit figure of Œdocladium. This uniformity of scale is a great convenience in actual use of the work.

The standard work on this family has been Wittrock's *Prodromus Monographiæ Œdogoniearum*, published in 1874. In this are represented 140 species, but only a single plate, of general types, accompanied the work. In a family like this, where the vegetative characters are of great simplicity, the need of accurate figures increases even more rapidly than the number of species; the best of descriptions are insufficient. So that, though De Toni's *Sylloge Algarum* gives descriptions of all species published up to 1889, it is extremely difficult to determine species by it. Dr. Hirn had the advantage of study with Wittrock and Nordstedt, had opportunity to examine type specimens of nearly all species, and had been receiving material from collectors in all parts of the world for a number of years. As a result, the list of habitats includes all parts of the earth; even South America, generally an algological *terra incognita*, being quite well represented. North America, though with few exclusive species, shows quite a rich flora, but the author wisely places a (?) against those references in Wolle which he has not been able to verify by authentic specimens. Of the 244 species, forty-five are described here for the first time.

F. S. COLLINS.

Notes. — *Biltmore Botanical Studies* is the title of a new journal of botany embracing papers by the director and associates of the Biltmore herbarium, the first number of which was issued on the 8th of April. It is published at Biltmore, N. C. The first number contains a revision of the species of Marshallia and descriptions of a considable number of new species of other genera.

Fascicle 1 of Vol. II of *Plantæ Bakerianæ*, by Professor E. L. Greene and others, covering fungi to grasses of Mr. Baker's collections of 1899, has been issued under date of March 11.

The first part of the "Illustrations of the botany of Captain Cook's voyage round the world in H.M.S. *Endeavour*, in 1768–71," by Banks and Solander, with determinations by James Britten, recently issued by order of the Trustees of the British Museum, contains one hundred folio plates representing Australian plants.

Parts II and III of Mr. F. Manson Bailey's *Queensland Flora*, published under the authority of the colonial government, have been issued and cover the orders Connaraceæ to Gentianaceæ, inclusive.

A new edition of Pond and Clements's *Phytogeography of Nebraska* has been brought out. Only one hundred copies are offered for sale, and as the work possesses real and general merit, though its purpose is local, the edition is likely to be soon exhausted.

Dr. Holm publishes a fifth list of additions to the flora of Washington, D. C., in the *Proceedings* of the Biological Society of that city, under date of April 2.

A supplement to *The Flora of the Upper Susquehanna and its Tributaries*, by Willard N. Clute, is published by the author at Binghamton, N. Y., under date of February 15.

The opening part of Vol. XV of the *Transactions of the Linnæan Society* consists of a report on botanical collections from Mount Roraima, in British Guiana.

An article on the determination of the type in composite genera and species, by President Jordan, appears in *Science* for March 29.

A paper on the Ranunculaceæ of Iowa, by T. J. and M. F. L. Fitzpatrick, is reprinted from the *Bulletin* of the laboratory of natural history of the University of Iowa.

The germination of *Bertholletia excelsa* is described in a well-illustrated article by William Watson, of Kew, in the *Annals of Botany* for March.

A paper dealing with American plants that is likely to be overlooked is E. H. L. Krause's "Nova Synopsis Ruborum Germaniæ et Virginiæ," the first part of which was published by the author in 1899 at Saarlouis.

In an account of a collection of Cratægus from near Montreal, made by Mr. Jack, Professor Sargent, in *Rhodora* for April, describes six additional new species.

Dr. Rydberg describes further new Potentillas in the *Bulletin of the Torrey Botanical Club* for March.

Eupatorium boreale is the name proposed in *Rhodora* for April by Professor Greene for what commonly passes in New England as *E. ageratoides*.

The genus Teucrium, as it is represented in the eastern United States, is passed in review by Bicknell in the *Bulletin of the Torrey Botanical Club* for March.

A supposedly new horse gentian is described from the northern states by Bicknell, under the name *Triosteum aurantiacum*, in *Torreya* for March.

Miss Eastwood describes some small-flowered Nemophilas from the Pacific coast in the *Bulletin of the Torrey Botanical Club* for March.

Engler's *Botanische Jahrbücher* of March 12 contains a paper by Lopriore on the geographical distribution of Amarantaceæ with reference to their relationships.

Pentstemon heterophyllus is illustrated in the *Revue Horticole* of April 1.

Alœ Lynchii, an artificial hybrid between *Alœ striata* and *Gasteria verrucosa*, is figured in the *Gardeners' Chronicle* of March 30. As with most bigeneric hybrids, this is a cross between representatives of genera which, though logically separable, are capable of treatment as sections of a single genus.

A number of new or little known grasses are described in *Circular No. 30* of the Division of Agrostology of the United States Department of Agriculture.

A portrait of Mr. George E. Davenport appears as the frontispiece to *The Fern Bulletin* for April.

Several American species of Cypripedium are photographically illustrated in *Die Gartenwelt* of March 16, in an article on their cultivation.

Poisoning by the pileate fungi, which has recently been exhaustively treated by Gillot in a thick volume published by the house of P. Klincksieck of Paris, is the subject of a number of recent notes in the *Bulletin de la Société des Naturalistes de l'Ain*. Of 222 cases of poisoning, the records of which were examined by Gillot, 86 resulted fatally, and of these 2 were doubtful and the other 84 were due to Amanitas or Volvarias.

Professor Peck's quarto plates illustrating the edible fungi of New York, with a number of additional plates and revised letter-press, have been issued as Vol. IV, No. 3, of the *Memoirs of the New York State Museum.*

A study of *Boletus luteus*, deformed by the parasitic *Hypomyces chrysospermus*, by Van Bambeke, appears in the recently issued *Bulletin de la Société Royale de Botanique de Belgique* for 1900.

A new species each of Tolyposporium and Ustilago in the ovaries of *Eriocaulon septangulare*, from Massachusetts, is described by Clinton in *Rhodora* for April.

The cambial slime diseases of trees are being rediscussed by Dr. Holtz in current numbers of the second Abteilung of the *Centralblatt für Bakteriologie*, etc.

Dr. E. F. Smith has published an extended and well-illustrated résumé of what is known of bacterial plant diseases, in recent numbers of the *Centralblatt für Bakteriologie*, Abteilung 2.

A paper on the organography and taxonomy of Galaxaura, a genus of red algæ, by Kjellman, is separately issued from the *K. Svenska Vetenskaps-Akademiens Handlingar*, Vol. XXXIII, No. 1.

Nowhere have ecological facts found so good exposition in gardening as at the Berlin botanical garden, where, from the moment of assuming the direction of the establishment, Dr. Engler has devoted himself to a development of this most important museum feature of a botanical garden. One of the most instructive of recent treatises on the ecological distribution of plants is issued as Appendix No. 7 to the current volume of the *Notizblatt* of the Berlin garden, and consists in a terse logical analysis of the plant formations of the Alps as exemplified in the newly established garden at Dahlem.

An extensive and well-illustrated treatise on the dissemination ecology of Scandinavian plants, by Dr. Rutger Sernander, is distributed from the University of Upsala, and forms an octavo of over 450 pages, the Swedish text being accompanied by a German summary.

A good example of what Huth has called stem-fruiting plants is given in a plate of *Artocarpus integrifolia*, published by Dr. Wilcox in the *Proceedings of the Columbus Horticultural Society* for 1900.

R. E. B. McKenney publishes some illustrated ecological notes on plant distribution in the *Beihefte zum Botanischen Centralblatt*, Bd. X, Heft 3.

Dr. Clements, of the University of Nebraska, is to conduct a class in field ecology in the higher mountains of Colorado next summer, extending through the months of July and August. The class should be large and enthusiastic.

The photosynthetic activity of chlorophyll occurring below corky tissue in the stems of several plants is discussed by Mlle. Goldflus in the *Revue Générale de Botanique* of February 15.

The apparatus of transpiration, or sudation, as the author prefers to call it, is discussed by Goffart in Vol. XXXIX of the *Bulletin de la Société Royale de Botanique de Belgique.*

"The Indian doctor's dispensatory, being Father Smith's advice respecting diseases and their cure, by Peter Smith of the Miami country," published in Cincinnati in 1812, is reprinted as No. 2 of the "reproduction series" of the *Bulletin of the Lloyd Library.* It is accompanied by a biography by John Uri Lloyd.

A neat little book on alpine plants and their cultivation, by W. A. Clark, has been brought out for the author by L. Upcott Gill of London and Charles Scribner's Sons of New York. It is illustrated by a number of exquisite half-tones showing some of the choicer species as grown in artificial rockeries.

Portraits of a number of the American botanists of the last two centuries are published in the recently issued second part of the *Report of the U. S. National Museum* for 1896–7.

PUBLICATIONS RECEIVED.

(Regular exchanges are not included.)

ARNOLD, AUGUSTA FOOTE. The Sea Beach at Ebb Tide. A Guide to the Study of the Seaweeds and the Lower Animal Life found between Tide Marks. New York, Century Company, 1901. x, 490 pp., 8vo, 85 pls., and many text-figs. $2.40. — ATKINSON, J. F. First Studies of Plant Life. Boston, Ginn & Company, 1901. xii, 266 pp., 8vo, 308 figs. — *Bibliographia Physiologica.* Vol. i, vol. ii, Nos. 1, 2. Turici, Concilii Bibliographici, 1898–99. — COMÈRE, J. Les Desmidices de France. Paris, Paul Klincksieck, 1901. 222 pp., 8vo, 16 pls. — DICKERSON, MARY C. Moths and Butterflies. Boston, Ginn & Company, 1901. xviii, 344 pp., 8vo, 233 figs., mostly photographs from life. — FRIEDLAENDER. Zoologisches Adressbuch. Teil ii. Berlin, R. Friedlaender & Sohn, 1901. viii, 517 pp., 8vo. 6 marks. — GANONG, W. F. A Laboratory Course in Plant Physiology, especially as a Basis for Ecology. New York, Henry Holt & Co., 1901. vi, 146 pp., 8vo, 35 figs. — HERRICK, F. H. The Home Life of Wild Birds. New York, Putnams, 1901. xix, 148 pp., 8vo, 130 figs. $2.50. — HOWARD, L. O. Mosquitoes: How they Live; How they Carry Disease; How they are Classified; How they may be Destroyed. New York, McClure, Phillips & Co., 1901. xv, 241 pp., 8vo, 50 figs. — MACDOUGAL, D. T. Practical Text-Book of Plant Physiology. New York, Longmans, Green & Co., 1901. xiv, 352 pp., 8vo, 159 figs. — SARS, J. O. An Account of the Crustacea of Norway, etc. Vol. iii, Cumacea. Pts. ix, x, Anatomy, Development, Supplement. Bergen Museum, 1900. x, pp. 93–115, Pls. LXV–LXXII. — SCHMEIL, O. Text-Book of Zoölogy treated from a Biological Standpoint. Translated from the German by Rudolf Rosenstock. Edited by J. T. Cunningham. London, Adam and Charles Black, 1901. xvi, 493 pp., 8vo, numerous illustrations. $4.00. — SEELIGER, O. Tierleben der Tiefsee. Leipzig, Engelmann, 1901. 49 pp., 8vo, 1 col. pl. 2 marks. — WRIGHT, MABEL OSGOOD. Flowers and Ferns in their Haunts. New York, Macmillan, 1901. xix, 358 pp., 8vo, illustrated. $2.50.

CHESTNUT, V. K., and WILCOX, E. V. The Stock-Poisoning Plants of Montana. U. S. Dept. Agr., Div. Bot., *Bull. No. 26.* 150 pp., 36 pls. — COQUILLETT, D. W. A Systematic Arrangement of the Families of Diptera. *Proc. U. S. Nat. Mus.* Vol. xxiii, pp. 653–658. — CORBETT, L. C. Sprayings. Results of Season 1900. *Bull. No. 70,* W. Va. Agr. Exp. Sta. Pp. 353–382, 17 figs. — DURY, C. A New Colandrid from Cincinnati, Ohio. *Journ. Cin. Soc. Nat. Hist.* Vol. xix, No. 8, pp. 243, 244, 1 fig. — FRAPS, J. S. The Nature of Pentosoids and their Determination. *Bull. No. 178,* N. C. Agr. Exp. Sta. Pp. 63–74. — GESTRO, R. Catalogo Sistematico dei Paussidi. *Ann. Mus. Civico Stor. Nat. Genova.* Vol. xv, 42 pp., figs. — GESTRO, R. Materiali per la Conoscenza della Fauna Erètrea Raccolti dal Dott. Paolo Magretti. *Ann. Mus. Civico Stor. Nat. Genova.* Vol. xx, 6 pp. — GIDLEY, J. W. Tooth Characters and Revision of the North American Species of the Genus Equus. *Bull. Amer. Mus.*

Nat. Hist. Vol. xiv, pp. 91–141, 4 pls., 22 figs. — GILL, T. The Proper Names of Bdellostoma or Heptatrema. *Proc. U. S. Nat. Mus.* Vol. xxiii, pp. 735–738. — GRAVE, C. The Oyster Reefs of North Carolina: A Geological and Economical Study. *Johns Hopkins Univ. Circ. No. 151.* 9 pp., map. — HINE, J. S. Review of the Panorpidæ of America North of Mexico. *Bull. Sci. Lab. Den. Univ.* Vol. xi, pp. 240–264, Pls. LIX–LXI. — HYAMS, C. W. Edible Mushrooms of North Carolina. *Bull. No. 177,* N. C. Agr. Exp. Sta. Pp. 27–58. — Indiana Department of Geology and Natural Resources. *Twenty-Fifth Annual Report,* 1900. xiii, 762 pp., plates, maps, and figs. W. S. Blatchley, state geologist. — LAMBE, L. M. A Revision of the Genera and Species of Canadian Palæozoic Corals. Contributions to Canadian Palæontology. Vol. iv, Pt. ii, pp. 97–197–ii, Pls. VI–XVIII. — LAMBE, L. M. Notes on a Turtle from the Cretaceous Rocks of Alberta. *Ottawa Naturalist.* Vol. xv, No. 3, pp. 63–67, 4 pls. — LYON, M. W. A Comparison of the Osteology of the Jerboas and Jumping Mice. *Proc. U. S. Nat. Mus.* Vol. xxii, pp. 659–668, Pls. XXV–XXVII. — MACDONALD, A. Study of Man. *Amer. Journ. Soc.* Vol. vi, No. 6, pp. 839–846. — MACDONALD, A. The Study of Children. *Everybody's Magazine.* June. — MASON, O. T. The Technic of Aboriginal American Basketry. *Amer. Anthrop.* Vol. iii, pp. 109–128, Figs. 8–39. — MASON, O. T. Printed Bark Canvas of the Kutenai and Amur. *Rept. U. S. Nat. Mus. for 1899.* Pp. 523–537, 5 pls. — MASON, O. T. A Primitive Frame for weaving Narrow Fabrics. *Rept. U. S. Nat. Mus. for 1899.* Pp. 485–510, 9 pls., 19 figs. — MAYER, A. G. The Variations of a newly arisen Species of Medusa. *Bull. Mus. Brooklyn Inst. A. and Sci.* Vol. i, No. 1, pp. 1–27, 2 pls. — MAXON, W. R. On the Ferns and Fern Allies of North America North of Mexico, with Principal Synonyms and Distribution. *Proc. U. S. Nat. Mus.* Vol. xxiii, pp. 619–651. — MERRIAM, J. C. A Contribution to the Geology of the John Day Basin. Univ. Cal., Dept. Geol., *Bull. No. 9.* Vol. ii, pp. 269–314. — MILLER, J. S., Jr. A New Deer from Costa Rica. *Proc. Biol. Soc. Wash.* Vol. xiv, pp. 35–37. — MILLER, J. S., Jr. A New Dormouse from Italy. *Proc. Biol. Soc. Wash.* Vol. xiv, pp. 39, 40. — MILLER, J. S., Jr. Five New Shrews from Europe. *Proc. Biol. Soc. Wash.* Vol. xiv, pp. 41–45. — NELSON, A. The Brome-Grasses of Wyoming. Wyo. Agr. Exp. Sta., *Bull. No. 46.* 18 pp., 9 figs. January. — NELSON, E. A Revision of Certain Species of Plants of the Genus Antennaria. *Proc. U. S. Nat. Mus.* Vol. xxiii, pp. 697–713. — NUTTING, C. C. Papers from the Harriman Alaska Expedition. XXI, The Hydroids. *Proc. Wash. Acad. Sci.* Vol. iii, pp. 157–216, Pls. XIV–XXVI. — SANDERSON, E. D. Twelfth Annual Report of the Entomologist of the Delaware College Agricultural Experiment Station for year ending June, 1900. Pp. 144–218, 3 pls., 15 figs. — SANDERSON, E. D. I, The Strawberry Root Louse. II, The Destructive Pea Louse in Delaware. Delaware Agr. Exp. Sta., *Bull. No. 49.* Pp. 1–24, 7 figs. — SHUFELDT, R. W. Osteology of the Penguins. *Journ. Anat. and Phys.* Vol. xxxv, pp. 390–404, Pl. XXXVIII. — SHUFELDT, R. W. Notes on the Osteology of *Scopus umbretta* and *Balæniceps rex. Journ. Anat. and Phys.* Vol. xxxv, pp. 405–412, Pl. XXXIX. — SMITH, H. S. Prehistoric Michigan. *Pop. Sci. News.* May, 1901. Pp. 110, 111, 6 figs. — STEJNEGER, L. Description of a New Species of Snake from Clarion Island, West Coast of Mexico. *Proc. U. S. Nat. Mus.* Vol. xxiii, pp. 715–717. — STEWART, J. H., and ATWOOD, H. Poultry Experiments. W. Va. Agr. Exp. Sta., *Bull. No. 71.* Pp. 385–402. — STEWART, J. H., and HITE, B. H. Commercial

Fertilizers. W. Va. Agr. Exp. Sta., *Bull. No. 72.* Pp. 1–32. — WALCOTT, C. D. Cambrian Brachiopoda: Obolella, Subgenus Glyptias; Bicia; Obolus, Subgenus Westonia; with Descriptions of New Species. *Proc. U. S. Nat. Mus.* Vol. xxiii, pp. 669–695. — WEINZIRL, J. The Bacterial Flora of the Semi-Desert Region of New Mexico, with Especial Reference to the Bacteria of the Air. *Journ. Cin. Soc. Nat. Hist.* Vol. xix, No. 7, pp. 211–242, 4 figs. — WHEELER, H. J., and TILLINGHAST, J. A. Rations for Milch Cows. R. I. Agr. Exp. Sta., *Bull. No. 77.* Pp. 131–174. — WITHERS, W. A., and FRAPS, J. S. The Relative Value of Some Nitrogenous Fertilizers. N. C. Agr. Exp. Sta., *Bull. No. 176.* Pp. 15–22.

American Museum Journal. Vol. i, Nos. 7–9. February, March. — *Bulletin Johns Hopkins Hospital.* Vol. xii, Nos. 121–123. April–June. — Hatch Experiment Station of the Mass. Agr. College. *Thirteenth Annual Report.* 1132 pp. — *La Nuova Notarisia.* Ser. xii. April. — *Memorias y Revistas de la Sociedad Científica "Antonio Alzate."* Tome xv, Nos. 3–6. — *Modern Medicine.* Vol. x, No. 4. April. — *Ohio Naturalist.* Vol. i, Nos. 6, 7. April, May. — *Revista Chilena de Historia Natural.* Año v, Nos. 3, 4. — *Science Gossip.* N.S., vol. vii, Nos. 83, 84. April, May. — *U. S. National Museum.* Report for year ending June 30, 1899. xv, 598 pp., pls. and figs.

(No. 415 was mailed July 31).